Appendices

Appendix A
Glossary

Glossary

ADA compliant sidewalks	Americans with Disabilities Act (ADA) compliant sidewalks possess a number of features that make them more accessible to individuals with disabilities. Standards define appropriate sidewalk width, surface texture, trip hazards, slope, and the availability of curb ramps.
Air Quality Index	Air Quality Index (AQI) is the nationally recognized indicator for reporting air quality. It runs from 0 to 500, and higher AQI values signify greater levels of air pollution and greater health concerns. A value below 50 (green) generally indicates good air quality, while a value above 300 (maroon) is hazardous.
anaerobic digestion	Anaerobic digestion is the process through which bacteria break down organic matter - which includes animal manure, biosolids, and food wastes - in an environment that lacks oxygen (usually a sealed vessel).
anti-idling	Motor vehicle emissions make up a significant portion of most cities' emissions. Anti-idling laws aim to reduce these emissions by requiring motorists to turn off their engines when parked, stopped, or standing for more than a set amount of time (three minutes, for example).
BEV/HEV vehicles	BEVs are Battery Electric Vehicles, which are powered solely by an electric battery with no gas engine parts. HEVs are Hybrid Electric Vehicles, which use an electric motor to assist gas-powered engines and all energy comes from gasoline.
bike-friendly infrastructure	Bike-friendly infrastructure is part of a "complete street" that is accessible and safe for all pedestrians, cyclists, public transit, and vehicles. It includes bikeways, lanes for bikes, shared use and quiet-street bike routes, painted buffer lanes, and conventional bike lanes, among others.
blower duct/duct leakage testing	Blower door and duct leakage tests measure the air flow that passes through a duct system. These tests can help to identify inefficiencies and make repairs that will lead to lower energy bills, improved air quality, and better performance.
carbon sequestration	Carbon sequestration is the process for capturing and storing atmospheric carbon dioxide, used to reduce the overall amount of carbon dioxide in the atmosphere and reduce the effects of global warming.
clean energy	Clean energy is energy derived from renewable, zero-emissions sources, as well as energy saved through energy efficiency measures. Renewable energy comes from natural processes, and energy efficiency reduces the amount of energy required. A clean energy economy powered by both renewables and energy efficiency is the most sustainable energy planning scenario.

circular economy	Circular economies share three principles: design out waste and pollution, keep products and materials in use, and regenerate natural systems. These circular economies aim to gradually decouple economic activity from the consumption of finite resources by promoting waste reduction and materials reuse.
climate neutral	Climate neutrality is achieved by balancing the amount of emissions generated with Earth's natural capacity to absorb them. It does not necessarily mean zero emissions, but reaching an equilibrium between emissions and absorptive capacity.
combined heat and power (CHP)	Combined heat and power (CHP) is an energy efficient technology that generates electricity and captures the heat that would otherwise be wasted to provide thermal energy used for heating, such as steam or hot water. CHP can work at an individual facility or building and be used in both residential and industrial processes, though it is most common in industrial settings.
composting	Composting is the natural process of recycling organic matter (leaves, food scraps) into a fertilizer. Anything that grows can decompose and composting helps to speed up this process.
design phase	The design phase is the design of a building construction or renovation project, inclusive of the issuance of a request for proposal and the project budget approval.
e-mobility	E-mobility, short for Electro Mobility, is the concept of using electric powertrain technology to enable electricity-powered modes of transportation. This can include full electric vehicles, plug-in hybrid vehicles, e-bikes, and other modes of transportation that use electricity to "go.".
energy burden	Energy burden means the percentage of household income that goes toward energy costs. Low income, African American, Latino, and people who rent often have a much higher energy burden than the average household.
energy efficient retrofits	Retrofits for energy can include improvements or modifications that may improve energy efficiency or decrease energy demand. These have the potential to reduce operational costs and help meet market expectations for newer buildings.
Energy Star standards	Energy Star standards are government-based benchmarks for energy efficiency in over 70 products.
EnergyCap	EnergyCAP is an energy management and utility bill software that allows users to benchmark buildings, analyze energy data use, and automate many accounting and management tasks.
environmental justice	Environmental justice is the fair treatment and meaningful involvement of all people – regardless of race, color, national origin, or income – with respect to the development, implementation and enforcement of environmental laws, regulations and policies. No group should bear a disproportionate share of negative environmental impacts resulting from industrial, governmental and commercial operations or policies.

equity	From the City of Richmond Equity Agenda: The City's definition of "equity" is to "empower people and communities that have experienced past injustices by removing barriers to access and opportunity" The City recognizes its duty to remove barriers (including educational, economic, and physical barriers, such as roads and access to affordable housing) to ensure greater access to resources and opportunities The City understands and appreciates that advancing racial equity not only improves the lives of those who have faced injustice, but also leads to a higher quality of life for people of all backgrounds
e-waste	E-waste, short for electronic waste, refers to electronic products that are nearing the end of their useful life. Certain components of e-waste contain materials that can make them hazardous to human and environmental health.
food waste diversion	Food waste diversion aims to redirect organic waste from the landfill and use it as a more useful resource. Food waste in landfills can contribute to global warming by emissions of carbon dioxide and methane gas that are released as it breaks down.
green infrastructure	Green infrastructure is any of a range of measures that use plant or soil systems, permeable pavement (or other substrates), stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspirate stormwater and reduce flows to sewer systems.
green roofs	Green roofs, also called rooftop gardens, are a vegetative layer grown on a rooftop. Green roofs provide shade, remove heat from the air, and reduce temperatures on the roof surface and surrounding air; as such, they have been found to reduce the heat island effect and reduce building energy usage.
greenway	Greenways are open space corridors that can be managed for conservation, recreation, and alternative transportation. They usually follow natural or existing land or water features. They serve to connect people and communities, provide recreational outdoor space, link cultural and historic sites, provide refuge for wildlife, and numerous other benefits.
health impacts of climate change	Climate change influences human health and disease in numerous ways, and will intensify some existing health threats while creating new ones. Emerging health threats include respiratory and cardiovascular disease, injuries, premature deaths related to extreme weather events, changes in the prevalence and distribution of food and water-borne illnesses, and threats to mental health.
high-performance buildings	A high-performance building considers public building design, construction, and renovation programs that achieve certification using the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) green building rating standard or the Green Building Initiative's 'Green Gloes' building standard, or meets the requirements of VEES.

human-centered design	Human-centered design (HCD) values the perspectives and knowledge of those most affected by the challenges and potential solutions to a problem. There are generally multiple phases that progress from establishing a basic understanding of the problem or opportunity to implementing and testing ideas.
industrial waste	Industrial waste is an all-encompassing term used to describe material considered to be no longer of use after a manufacturing process has been completed. It can be hazardous or non-hazardous, although both can harm the environment if not properly managed. It can also include solid waste, toxic waste, chemical waste, and secondary waste (e.g., scraps, construction materials).
municipal energy management plan	Municipal energy management plans aim to reduce their city's energy usage through a strategic plan for local government operations. The typical goal of these plans is to reduce energy consumption by practicing energy efficiency and environmental stewardship across city operations. Most of these plans work within a SMART framework.
neighborhood amenities	Neighborhood amenities contribute to community life and enjoyment, and can include schools, stores, parks, and restaurants, for example. Families that live in neighborhoods with more of these community amenities tend to report more trust, sociability, and neighborliness and less loneliness and other maladies.
net-zero energy	Net zero energy is a concept defined by the use of energy conservation, energy efficiency, and on-site renewable generation to account for 100% of a targeted building's or community's energy usage.
organic waste	Organic waste is any material that is biodegradable and comes from either a plant or animal.
Portfolio Manager	Portfolio Manager is a tool created by the EPA to measure and track energy and water consumption and greenhouse gas emissions. It can be used to benchmark the performance of one building or a whole portfolio of buildings.
public-private partnerships	A long-term contract between a private party and a government entity, for providing a public asset or service, in which the private party bears significant risk and management responsibility and remuneration is linked to performance.
regeneration of ecosystems	Ecosystem regeneration seeks to restore the vital ecosystem services that play an important role in human society, such as providing food, drinking water, materials, and fuel, as well as broader climate regulation. Urban sustainable regeneration focuses on the complex interactions between urban environments and ecosystems and attempts to implement planning processes that consider both.

resilient infrastructure	Climate-resilient infrastructure is planned, designed, built, and operated in a way that anticipates, prepares for, and adapts to changing climate conditions. It can withstand disruptions caused by these climate conditions. It can include retrofits to existing infrastructure, new infrastructure, and new additional infrastructure such as sea walls.
retro-commissioning	Retrocommissioning is the first step in the building upgrade process. Commissioning outlines the interactions across all the energy flows in a building and produces a systematic method for planning upgrades that increase energy savings. It ensures that all systems are designed, installed, functionally tested, and capable of being operated and maintained according to the owner's needs, and retrocommissioning simply applies this process to existing buildings that have never been previously commissioned.
smart cities infrastructure	Smart cities are a framework, mostly comprising communication and information infrastructures and technologies, to develop, deploy, and promote sustainable development practices to address urbanization challenges. It facilitates a more interconnected city that can improve energy distribution, streamline trash collection, decrease traffic congestion, and improve air quality, for example.
targeted universalism	Targeted universalism is an engagement and implementation framework that acknowledges that one size does not fit all - in terms of solutions, programs, and more - and is inclusive of the needs of both dominant and marginalized groups. However, it pays particular attention to the situation of the marginalized group in its development, implementation, and ongoing evaluation.
transportation accessibility	Transportation accessibility measures how much you can get to in a given amount of time. It works jointly with transportation multimobility to determine the overall accessibility of a transportation system.
transportation demand management	Transportation Demand Management (TDM) focuses on understanding how people make their transportation decisions and helping people use the infrastructure in place for transit, ridesharing, walking, biking, and telework. It seeks to ensure that the design of transportation and physical infrastructure naturally encourages alternatives to driving.
transportation multimobility	Multimobility means combining a variety of transportation methods to move around.
upstream emissions	Upstream emissions are emissions that are generated from production and processing operations, rather than the direct burning of fossil fuels. These often rise the total energy expenditures of production processes, such as the extra upstream emissions required to dilute or heat bitumen in oil sands deposits.
Virginia Energy Conservation & Environmental Standards (VEES)	VEES are a series of conservation and environmental standards in place to guide construction and new development in Virginia.

vulnerability to climate change	Vulnerability to climate change encompasses physical, ecological, and social aspects that stem from increased extreme weather events, rising temperatures, changing precipitation patterns, sea level rise, and other aspects of climate on which the environment and human systems depend.

Appendix B
City Council Resolutions Supporting Climate Action

INTRODUCED: March 9, 2020

A RESOLUTION No. 2020-R024

To recognize the effects of global warming caused by human activity and to establish a climate action goal to achieve a 45 percent reduction in greenhouse gas emissions by 2030 and net zero greenhouse gas emissions by 2050 from the 2008 baseline.

Patron – Mayor Stoney

Approved as to form and legality
by the City Attorney

PUBLIC HEARING: APR 13 2020 AT 6 P.M.

WHEREAS, by Resolution No. 2012-R69-103, adopted July 9, 2012, the City adopted a sustainability plan for the City of Richmond entitled "RVAgreen: A Roadmap to Sustainability," which builds on existing sustainability efforts and priorities of the City of Richmond divided into five focus areas: Economic Development, Energy, Environment, Open Space, and Land Use and Transportation; and

WHEREAS, the Council believes that the City must remain committed to the sustainability goals articulated in the aforementioned plan as the City develops a new equity-centered, integrated climate action and resilience plan; and

AYES: 8 NOES: 0 ABSTAIN: _____

ADOPTED: JUN 8 2020 REJECTED: _____ STRICKEN: _____

WHEREAS, upon information and belief of the Council, global temperatures have already risen by one degree Celsius from pre-industrial levels, and the effects of climate change are evident in, among other things, extreme weather conditions, rising air and water temperatures, changes in precipitation, and declining surface water quality; and

WHEREAS, upon information and belief of the Council, the United Nations Intergovernmental Panel on Climate Change released a special report in October 2018 concerning global warming that concluded that if global temperatures rise above 1.5 degrees Celsius relative to pre-industrial levels, worldwide risks for flooding of major coastal cities, the breakdown of agricultural systems, mass migration, and catastrophic weather events that pose significant threats to human society will increase; and

WHEREAS, upon information and belief of the Council, the said special report of the United Nations Intergovernmental Panel on Climate Change concluded that carbon dioxide emissions must be reduced by 45 percent from 2010 levels by 2030 and reach net zero by 2050 in order to stabilize a 1.5 degrees Celsius temperature increase to prevent disastrous effects on global climate, ecosystems, and human societies; and

WHEREAS, upon information and belief of the Council, the City of Richmond's greenhouse gas emissions account for four percent of the community's total emissions and residents and businesses account for 96 percent, thereby making community education and engagement on issues of climate change critical; and

WHEREAS, upon information and belief of the Council, the overwhelming weight of scientific evidence indicates that global warming is caused by emissions of carbon dioxide, methane, and other greenhouse gases into the atmosphere from human activities, primarily from the combustion of fossil fuels; and

WHEREAS, in addition to the environmental effects of climate change, the Council believes that the City must also address how climate change affects communities within the city of Richmond and worldwide as climate change relates to race, socio-economic status, and inequity for people of color, immigrants, indigenous communities, low-income individuals, and persons with disabilities; and

WHEREAS, the Council believes that homeless persons are disproportionately affected by climate change, and will continue to bear an excess burden from increasing temperatures, the rise of sea levels, the spread of disease, and the economic consequences of inaction on the climate crisis; and

WHEREAS, the Council believes that, in order to benefit all communities within the city of Richmond, the City must maintain its commitment to climate action, climate resilience, and sustainability policies that address the specific experiences, vulnerabilities, and needs of the most defenseless communities within the city of Richmond by engaging such communities in climate mitigation and climate resilience planning; and

WHEREAS, the Council believes that the costs of addressing the climate crisis are far less than the costs of not addressing the climate crisis and that solving the crisis will take significant public investment, education, commitment and resolve; and

WHEREAS, upon information and belief of the Council, the City has taken steps to reduce greenhouse gas emissions and prepare for the local impacts of climate change, including adopting the Paris Climate goals to limit the global temperature increase to 1.5 degrees Celsius on the municipal level and setting a target for municipal and community-wide greenhouse gas emissions reductions of 80 percent by 2050; and

WHEREAS, the Council believes that, even with these commitments, the impacts of climate change globally and locally require greater action and leadership in order to reach global net-zero emissions by 2050; and

WHEREAS, the Council believes that developed economies, which are well-equipped to rapidly transition to renewables, may need to increase their sustainability efforts as the climate crisis progresses; and

WHEREAS, upon information and belief of the Council, the City would be joining other jurisdictions within the Commonwealth of Virginia that are leading by example, including Albemarle County, Alexandria, Arlington, and Charlottesville, in the commitment to carbon neutrality by or before 2050, and the Commonwealth of Virginia, which is committed to 100 percent of Virginia's electricity from carbon-free sources by 2050; and

WHEREAS, the Council believes that each individual has an obligation to participate in sustainability efforts, mitigate the effects of climate change for future generations, take unprecedented action to lead and empower community-wide greenhouse gas emissions reductions, and prepare the city of Richmond for the effects of climate change; and

WHEREAS, the Council believes that, in light of the foregoing, it is in the best interests of the citizens of the City of Richmond that the Council recognize the effects of global warming and establish a climate action goal for the City of Richmond to achieve a 45 percent reduction in greenhouse gas emissions by 2030 and net zero gas emissions by 2050 from the 2008 baseline;

NOW, THEREFORE,

BE IT RESOLVED BY THE COUNCIL OF THE CITY OF RICHMOND:

That the Council hereby recognizes that global warming caused by human activity increases emissions of greenhouse gases and has resulted in a climate crisis that threatens

communities within the city of Richmond, the Richmond region, the Commonwealth of Virginia, communities around the nation, and civilizations and ecosystems worldwide.

BE IT FURTHER RESOLVED:

That the Council hereby establishes a climate action goal for the City of Richmond to achieve a 45 percent reduction in greenhouse gas emissions by 2030 and net zero greenhouse gas emissions by 2050 from the 2008 baseline.

BE IT FURTHER RESOLVED:

That the Council calls on the United States Government, Congress, the Commonwealth of Virginia, and other local governments to recognize that global warming caused by human activity that increases emissions of greenhouse gases has resulted in a climate crisis; to initiate a just transition and mobilization effort to restore a safe climate and build a sustainable economy; and to convey the urgency of global warming awareness to the public.

BE IT FURTHER RESOLVED:

That the Council hereby supports the commitment to a citywide just transition and mobilization effort to reverse global warming and is dedicated to utilizing any financial and regulatory assistance from the Commonwealth of Virginia and the United States Government, to the extent permitted by law, for the purpose of ending citywide greenhouse gas emissions as quickly as possible, initiating efforts to safely draw down carbon from the atmosphere, and accelerating adaptation and resilience strategies in preparation for intensifying climate impacts.

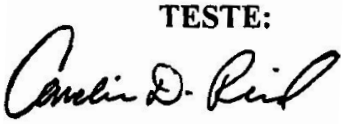
BE IT FURTHER RESOLVED:

That the Council hereby supports the climate resilience goal for the City of Richmond to prepare for, adapt, and improve its resilience to the local impacts of climate change.

BE IT FURTHER RESOLVED:

That the Council hereby supports the development and implementation of an equity-centered, integrated climate action and resilience plan to advance the climate action and resilience goals; the education of residents and businesses on matters related to the climate crisis; and full community participation, inclusion, and recognition of the residents and businesses within the city of Richmond, along with community organizations dedicated to faith, youth, labor, academic institutions, civic participation, and marginalized populations, and other such community allies, who will be integral to the climate action plan development and implementation and mobilization effort.

A TRUE COPY:
TESTE:



City Clerk

CITY OF RICHMOND

INTRACITY CORRESPONDENCE

O & R REQUEST
2020-020
FEB 13 2020

Office of the
Chief Administrative Officer

O&R REQUEST

DATE: February 12, 2020 **EDITION:** 1

TO: The Honorable Members of City Council

THROUGH: The Honorable Levar M. Stoney, Mayor 2/27/2020

THROUGH: Lenora G. Reid, Acting Chief Administrative Officer

THROUGH: Sharon Ebert, Deputy Chief Administrative Officer

THROUGH: Reginald Gordon, Deputy Chief Administrative Officer

THROUGH: Robert C. Steidel, Deputy Chief Administrative Officer

RECEIVED
FEB 27 2020
OFFICE OF THE CITY ATTORNEY

FROM: Alicia Zatcoff, Sustainability Manager AZ

RE: Net Zero Emissions Resolution

ORD. OR RES. No. _____

PURPOSE: To recognize that global warming caused by human activity that increases emissions of greenhouse gases has resulted in an urgent climate situation and to adopt climate action and resilience goals for the City of Richmond and community.

REASON: The adoption of climate action and resilience goals, including a net zero greenhouse gas emissions reduction goal, is necessary for the City of Richmond to combat the urgent climate challenge that faces our community and will create broad social, environmental, and economic benefits for the community.

RECOMMENDATION: Adopt the attached resolution that recognizes a climate crisis and adopts climate mitigation and resilience goals for the City of Richmond and community.

BACKGROUND:
Scientific evidence is conclusive that global warming is caused by emissions of carbon dioxide and other greenhouse gases into the atmosphere from human activities (i.e. burning fossil fuels), and that global warming causes climate change. The United Nations Intergovernmental Panel on Climate Change (IPCC), the leading body for assessing the science regarding climate change, released a special report in October 2018 on Global Warming of 1.5° C that concluded that if global temperatures rise above 1.5° C relative to pre-industrial levels we face elevated risks

worldwide associated with potential flooding of major coastal cities, the breakdown of agricultural systems, mass migration, and catastrophic extreme weather events that pose significant threats to human society. There is a consensus among scientists, as described in the United Nations' IPCC report, that we must reduce carbon dioxide emissions by 45% from 2010 levels by no later than 2030 and reach net zero around 2050, in order to stabilize a 1.5° C temperature increase to have a chance at avoiding profound and disastrous impacts on global climate, ecosystems, and human societies.

Localities around the world and their residents are bearing the brunt of climate change impacts and will continue to do so at an increasing level into the future. In Richmond, that means a greater frequency and intensity of heat events, record-breaking rainfall, more extreme weather events, and other disruptions that threaten our residents' health, economic security, and quality of life as well as compromise community infrastructure, built assets, and natural resources.

In our community, it is not possible to address climate change without also confronting racial, socio-economic and other inequity, and vice versa. In Richmond, frontline communities including people of color, low-income individuals, immigrants, indigenous communities, people with disabilities and the unhoused are already disproportionately impacted by climate change, and will continue to bear an excess burden as climate impacts increase in the future.

However, the City of Richmond, can join other local governments leading with forward-thinking climate action that is needed now more than ever. The proposed resolution acknowledges the current climate science. It calls for revising the city's greenhouse gas emission reduction goals to a 45% reduction in community and city government greenhouse gas emissions by 2030, and net zero emissions by 2050 using a baseline year of 2008; and it calls for Richmond to prepare for, adapt and improve city government and community resilience to local climate hazards.

Accompanying these proposed goals is a pathway to advancing and achieving them through RVA Green 2050, the City's equity-centered, integrated climate action and resilience planning and implementation process. RVAgreen 2050 is a community-based process that will benefit the entire community by addressing the specific experiences, vulnerabilities, and needs of frontline communities within Richmond to include, support and empower those communities to participate in the planning and implementation of climate action and climate resilience policy and initiatives.

In 2019, Integral Group, LLC donated goods and services to complete energy and greenhouse gas emissions modeling to show potential pathways and scenarios for achieving the 80% by 2050 greenhouse gas emission reduction goal. This work was made possible by support from the Energy Foundation via Council's adoption of Ord. No. 2018-045. In 2020, Greenlink Analytics, Inc., is donating goods and services to build upon the energy and greenhouse gas emission modeling conducted by Integral Group and updating it to show potential pathways and scenarios for achieving the goals of a 45% reduction in community and city government greenhouse gas emissions by 2030, and net zero emissions by 2050. This work was made possible by support from the Energy Foundation via Council's adoption of Ord. No. 2019-334.

The proposed Net Zero Carbon Resolution is aligned with City Council Focus Areas as well as Mayor Stoney's strategic priorities and it will create broad social, environmental, and economic benefits such as reducing air pollution and associated public health risks, improving water quality, saving residents and businesses money, providing clean, renewable energy and local employment opportunities, increasing transportation options available to residents, and addressing environmental justice challenges in our community.

FISCAL IMPACT / COST: None

FISCAL IMPLICATIONS: None

BUDGET AMENDMENT NECESSARY: No

REVENUE TO CITY: None

DESIRED EFFECTIVE DATE: Upon adoption

REQUESTED INTRODUCTION DATE: March 9, 2020

CITY COUNCIL PUBLIC HEARING DATE: March 23, 2020

REQUESTED AGENDA: Consent

RECOMMENDED COUNCIL COMMITTEE: Governmental Operations Committee

CONSIDERATION BY OTHER GOVERNMENTAL ENTITIES: City Attorney's Office

AFFECTED AGENCIES: Office of Sustainability, Departments of Public Works, Public Utilities, Department of Planning & Development Review, Economic Development, Housing & Community Development, Parks, Recreation & Community Facilities, Social Services, Justice Services, Budget & Strategic Planning

RELATIONSHIP TO EXISTING ORD. OR RES.: None

REQUIRED CHANGES TO WORK PROGRAM(S): None

ATTACHMENTS:
Net Zero Emissions Resolution
Green City Commission Support Letter

STAFF:
Alicia Zatcoff, Sustainability Manager, 646-3055

RICHMOND GREEN CITY COMMISSION

December 9, 2019

Dear Mayor Stoney and Richmond City Council Members,

The Richmond Green City Commission along with the undersigned businesses and organizations urge the adoption of the attached Resolution. The Resolution calls for:

1) a 45% greenhouse gas pollution reduction target by 2030 and carbon neutrality by 2050, and

2) Richmond to prepare for the local impacts of climate change, which include extreme heat, extreme rainfall and increased flooding.

As recognized when Richmond set the City's current goal of reducing greenhouse gas emissions 80% by 2050 under Mayor Stoney's leadership, climate change is already impacting the lives of families in our community. These impacts range from increasing the cost of food and housing to decreasing the quality of the air we breathe. Our low-income residents and people of color are on the frontlines of climate change where these impacts are likely to hit the hardest; families who struggle to afford to cool their homes will be even further strained as longer and hotter heat waves occur more often. And many of these frontline community members will also experience the worst effects of flooding from increasingly severe rainstorms. The importance of local government action has never been more urgent, and we applaud the Mayor and Council for your leadership to date on this critical issue.

Unfortunately, **new evidence shows that Richmond's current goal is inadequate.** Scientists across the globe are stating that the next 10 years will determine whether or not we are successful in avoiding the most catastrophic impacts of climate change and are calling for stronger steps to cut emissions, including substantial reductions by 2030 and net zero emissions by 2050. By adopting these science-based emissions targets, Richmond will join leading localities in Virginia like Alexandria, Arlington and Charlottesville and align itself with Governor Ralph Northam's Executive Order 43, which calls for the Commonwealth to achieve 100% carbon-free electricity by 2050. The City should also fully support the RVAgreen 2050 equity-centered climate action process to create and implement a roadmap for achieving these goals.

This letter is signed by a cross-sector of community supporters who want their Mayor and City Council to lead on climate action, and it illustrates that businesses, organizations, and residents are ready to take action to help reach these ambitious—yet necessary and achievable—goals. The Richmond Green City Commission and all of those signing this letter stand ready to support you in this process and appreciate your consideration of this request to adopt this critically important Resolution.

Sincerely,

Emily Francis

Emily Francis, Chair, Richmond Green City Commission

Community stakeholders who add their support to this letter:


VIRGINIA LEAGUE OF
CONSERVATION VOTERS


Citizens' Climate Lobby


ccan
CHESAPEAKE
CLIMATE
ACTION
NETWORK
ChesapeakeClimate.org


SOUTHERN
ENVIRONMENTAL
LAW CENTER


VIRGINIA
CONSERVATION
NETWORK


RREA
(Richmond Region Energy Alliance)


VIRGINIA
supportive
housing
CELEBRATING 30 YEARS
1988
2018


RVA
Rapid Transit

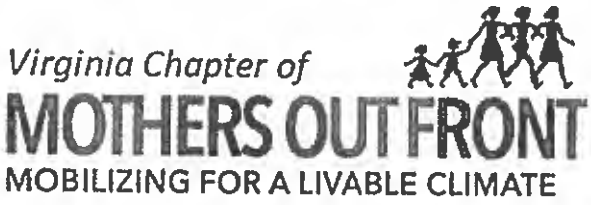

SHALOM
FARMS

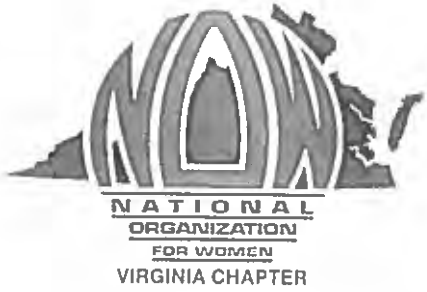

viridiant


dovetail


project:HOMES


ALLIANCE
for the Chesapeake Bay


Virginia Chapter of
MOTHERS OUT FRONT
MOBILIZING FOR A LIVABLE CLIMATE


NOW
NATIONAL
ORGANIZATION
FOR WOMEN
VIRGINIA CHAPTER

INTRODUCED: July 26, 2021

A RESOLUTION No. 2021-R049

To declare the existence of a climate and ecological emergency that threatens the city of Richmond, the surrounding region, the Commonwealth of Virginia, civilization, humanity, and the natural world.

Patrons – All Members of Council

Approved as to form and legality
by the City Attorney

PUBLIC HEARING: SEP 13 2021 AT 6 P.M.

WHEREAS**,** in Chapter 6 of the City's Master Plan entitled "Richmond 300: A Guide for Growth" (hereinafter referred to as the "Master Plan"), approved by Ordinance No. 2020-236, adopted December 14, 2020, Goals 15, 16 and 17 outline a vision for a sustainable and resilient city with healthy air, clean water, and a flourishing ecosystem; and

WHEREAS, upon information and belief of the Council, there is a consensus among scientists, as described in the recent United Nations' Intergovernmental Panel on Climate Change report, and further reflected in the City's RVAgreen 2050 plan goals, that the City must reduce carbon dioxide emissions by 45 percent from 2010 levels by no later than 2030, and reach

AYES:	8	NOES:	0	AB0STAIN:	
ADOPTED:	SEPT 13 2021	REJECTED:		STRICKEN:	

net zero by 2050, in order to stabilize a 1.5° C (2.4° F) temperature increase to have a chance at avoiding profound and disastrous impacts on the city's local climate, ecosystem, and communities; and

WHEREAS, upon information and belief of the Council, climate stressors such as the urban heat island effect—whereby human-designed landscapes amplify local heat extremes by several degrees—have been shown by the Science Museum of Virginia to disproportionately impact historically redlined, majority Black neighborhoods in south and east Richmond and public housing communities, which lack the mature tree canopies that protect wealthier White neighborhoods in the northern and western parts of the city of Richmond; and

WHEREAS, upon information and belief of the Council, in addition to exacerbating the heat island effect, a lack of urban tree canopy worsens air pollution, harms wildlife, exacerbates erosion and stormwater issues, and threatens the economy and ecology of the city in a variety of interrelated ways; and

WHEREAS, upon information and belief of the Council, frontline communities in the city of Richmond and globally, including communities of people of color, immigrants, indigenous persons, low-income individuals, people with disabilities and the unhoused are already disproportionately impacted by climate change, and will continue to bear an excess burden from increasing temperatures, sea level rise, the spread of disease and the economic consequences of inaction on the climate crisis; and

WHEREAS, Council is of the opinion that justice calls for climate resilience that addresses the specific experiences, vulnerabilities, and needs of frontline communities within the city of Richmond, which must be included and supported in actively engaging in climate resilience planning, policy and actions; and

WHEREAS, Council is of the opinion that environmental racism is a systemic structure that undermines the health of Black residents of the city of Richmond, and Resolution No. 2021-R039, which is pending before the Council, states that the Council is committed to dismantling those systemic structures that undermine the health of Black people; and

WHEREAS, upon information and belief of the Council, over 1,910 local governments representing over 798 million people have already declared a state of climate emergency, including New York City, New York, Austin, Texas, Boulder, Colorado, San Francisco, California, Alexandria, Virginia, and 58 other localities within the United States, as well as 15 national governments, including those of the United Kingdom, Canada, France, Ireland and Argentina; and

WHEREAS, upon information and belief of the Council, the costs of the City's inaction on climate change far outweighs the costs of immediate mitigation efforts; and

WHEREAS, the Council believes that it is in the best interests of the citizens of the City of Richmond that the Council declare the existence of a climate and ecological emergency that threatens the city of Richmond, the surrounding region, the Commonwealth of Virginia, civilization, humanity, and the natural world;

NOW, THEREFORE,

BE IT RESOLVED BY THE COUNCIL OF THE CITY OF RICHMOND:

That the Council hereby declares the existence of a climate and ecological emergency that threatens the city of Richmond, the surrounding region, the Commonwealth of Virginia, civilization, humanity, and the natural world, and commits to pursuing all of the legislative goals outlined in this resolution and the City's RVA Green 2050 plan.

BE IT FURTHER RESOLVED:

That the Council hereby commits to a just and equitable transition for residents that includes the full participation, support, and leadership of community organizations, faith communities, youth, labor organizations, academic institutions, indigenous groups, and racial, gender, family, immigrant and disability justice and organizations and other allies as are integral to the climate change crisis response and mobilization efforts.

BE IT FURTHER RESOLVED:

That the Council hereby commits to using a community engagement process and the Climate Equity Index of the RVA Green 2050 plan to keep the concerns of frontline and marginalized communities central to all climate mobilization planning processes and to invite and encourage such communities to actively participate in the revision and implementation of the RVA Green 2050 plan and all climate mobilization efforts.

BE IT FURTHER RESOLVED:

That Council hereby commits to working with City's Administration on legislative and funding opportunities, to the extent permitted by law, to address the climate and ecological emergency and its impacts through existing hazard mitigation programs and use of funds received pursuant to the American Rescue Plan Act of 2021, H.R. 1319, 117th Cong., 1st Sess. (2021-2022), other funds appropriated for infrastructure improvements, and such funds as may be proposed by the Mayor and appropriated by the Council.

BE IT FURTHER RESOLVED:

That the Council, in collaboration with the City's Administration, hereby commits to fund and empower the City's sustainability programs by creating a new Office of Sustainability, the agency head of which shall report to the Chief Administrative Officer and, as the Chief Administrative Officer may direct, to such City official charged by the Chief Administrative

Officer with the overall administration of the City's economic development projects and initiatives, to oversee a community-wide mobilization effort to be implemented by all departments and agencies of the City, and provide for the powers and resources necessary to coordinate the City's climate and environmental programs, including the revision and implementation of the RVA Green 2050 plan and detailing the actions and strategies necessary to implement climate crisis response, climate mitigation, resilience, adaptation, engagement, education, advocacy, and research and development programs.

BE IT FURTHER RESOLVED:

That the Council hereby commits to working with the City's Administration to more effectively utilize the Urban Forestry Commission, with the participation of a new urban forester position, should one be provided for in the annual budget for the fiscal year commencing July 1, 2022, and ending June 30, 2023.

BE IT FURTHER RESOLVED:

That the Council hereby commits to working with the City's Administration to provide for the creation of an urban forest master plan, to be prepared by a new urban forester, should one be provided for in the annual budget for the fiscal year commencing July 1, 2022, and ending June 30, 2023, that incorporates the findings of the City's RVA Green 2050 plan, the objectives of the Master Plan, the Department of Public Utilities' RVA H2O program, and the priorities of the City's Equity Agenda, as set forth in Resolution No. 2021-R032, adopted June 14, 2021, to increase the city-wide tree canopy from 42 percent to at least 60 percent and achieve at least 30 percent tree canopy in all neighborhoods, prioritizing areas with a high heat vulnerability index rating and low tree canopy coverage, and using shade sails and cooling stations to support communities while tree canopies develop.

BE IT FURTHER RESOLVED:

That the Council hereby commits to working with the City's Administration to implement a tax on disposable plastic bags at retail outlets, as authorized by section 58.1-1745 of the Code of Virginia (1950), as amended

BE IT FURTHER RESOLVED:

That the Council, prior to the imposition of a tax on disposable plastic bags, hereby commits to conducting a robust community engagement process to determine key equity challenges, and plan support for low-income city residents and small businesses to support such residents in a transition to reusable bags.

BE IT FURTHER RESOLVED:

That the Council, as may be proposed by the Mayor in the annual budget and to the extent permitted by law, hereby commits to appropriating revenues generated from a disposable plastic bag tax to support an equitable implementation of the disposable plastic bag tax, and to fund city projects that reduce greenhouse gas emissions in accordance with section 58.1-1745 of the Code of Virginia (1950), as amended, in connection with the City's sustainability programs.

BE IT FURTHER RESOLVED:

That the Council hereby commits to working with the City's Administration to identify lenders with which the City contracts that invest in fossil fuel companies, and then joining New Orleans, Louisiana, New York City, New York, Los Angeles, California, and other climate leaders in divesting from such lenders, and adopting a socially responsible banking policy.

BE IT FURTHER RESOLVED:

That the Council hereby commits to working with the City's Administration on an equitable plan to phase out reliance on gas and shift to accelerated investment in City-owned

renewable energy and hereby recognizes that the continued operation of the City's gas utility is an obstacle to the City's goal of Net-Zero emissions in accordance Resolution No. 2020-R024, adopted June 8, 2020.

BE IT FURTHER RESOLVED:

That the Council hereby commits to working with the City's Administration to petition the Virginia Soil and Water Conservation Board for the creation of a soil and water conservation district within the city of Richmond to ensure that residents, businesses and nonprofits within the city of Richmond have access to technical and financial support for projects to prevent soil erosion, prevent floods, and conserve, develop, utilize and dispose of water in order to build resilience as the climate continues to increase annual rainfall in the region.

BE IT FURTHER RESOLVED:

That the Council hereby supports the pursuit of a memorandum of understanding with the neighboring Henricopolis Soil and Water Conservation District located in Henrico County, Virginia to be effective by no later than June 30, 2023.

BE IT FURTHER RESOLVED:

That the Council commits to working with the City's Administration, including the Department of Public Utilities with regard to its RVA H2O program, the Richmond delegation to the General Assembly of Virginia, and the United States Congress to procure funding to modernize the City's combined sewer overflow system, prioritizing green infrastructure that reduces stormwater runoff including green roofs, street trees, rain gardens, bioretention areas, and permeable paving as part of a comprehensive strategy to reach compliance with state and federal water quality standards.

BE IT FURTHER RESOLVED:

That the Council hereby commits to working with the City's Administration to explore amending City policies to ban or significantly limit the use of synthetic pesticides and herbicides on City-owned property.

BE IT FURTHER RESOLVED:

That the Council hereby commits to working with the City's Administration to implement a clean and green fleet management plan by September 30, 2021, including the allocation of full funding towards phased implementation of the plan, as the Mayor may propose in the annual budget for the fiscal year commencing July 1, 2022, and ending June 30, 2023, and in annual budgets thereafter as the Mayor may propose.

BE IT FURTHER RESOLVED:

That the Council hereby commits to working with the City's Administration on the appropriate implementation of the Commercial Property Assessed Clean Energy Financing Program, as set forth in Chapter 11, Article VIII of the Code of the City of Richmond (2020), as amended, in order to promote the general health and welfare of the community.

BE IT FURTHER RESOLVED:

That the Council commits to working with the City's Administration to designate and, if necessary, provide funding for an existing or new position within the City carry out the duties of a green procurement officer by September 30, 2021, and to adopt, to the extent permitted by law, a green procurement policy.

BE IT FURTHER RESOLVED:

That the Council hereby commits to further endorse legislative proposals for submission to the Richmond delegation to the General Assembly of Virginia that reflect the policies set forth in this resolution, and to create a task force, the purpose of which shall be to ensure the timely

and equitable deliberation and implementation of the policy goals set forth in this resolution by September 30, 2021.

BE IT FURTHER RESOLVED:

That, in furtherance of the goals of this resolution, the Council hereby requests that the Chief Administrative Officer cause to be provided to the Council all relevant support and assistance as may be necessary to effectuate the objectives of this resolution cause the City's Administration to submit to the Council a report concerning the legislation that is necessary to implement the priorities set forth in this resolution by no later than January 1, 2022.

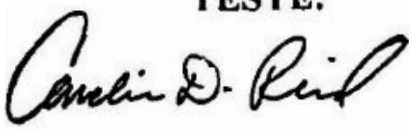
BE IT FURTHER RESOLVED:

That the City Clerk is directed to submit a certified copy of this resolution to the President of the United States, the United States Congress, and the Richmond delegation to the General Assembly of Virginia.

BE IT FURTHER RESOLVED:

That, for the avoidance of doubt, no statement contained in this resolution shall be deemed to constitute the consent of the City Council pursuant to section 44-146.21(A) of the Code of Virginia (1950), as amended, to the declaration of any local emergency pursuant to, or otherwise to authorize the activation of any provision of, the Commonwealth of Virginia Emergency Services and Disaster Law of 2000, Va. Code Ann. §§ 44-146.13—44-146.29:3 (2013 & Supp. 2020).

A TRUE COPY:
TESTE:



City Clerk

Richmond City Council
The Voice of the People
Richmond, Virginia
Office of the Council Chief of Staff

Ordinance/Resolution Request

TO Haskell Brown, Interim City Attorney

THROUGH Joyce Davis, Interim Council Chief of Staff

FROM Steven Taylor, Council Policy Analyst

COPY Katherine Jordan, 2nd District Council Member
Sven Philipsen, 2nd District Liaison
Tabrica Rentz, Interim Deputy City Attorney

DATE July 15, 2021

PAGE/s 1 of 2

TITLE Climate Crises Emergency

This is a request for the drafting of an **Ordinance** ☐ **Resolution** ☒

REQUESTING COUNCILMEMBER/PATRON
K. Jordan

SUGGESTED STANDING COMMITTEE
EHS

ORDINANCE/RESOLUTION SUMMARY
The patron request that legislation be drafted for Council's consideration declaring a climate emergency.

BACKGROUND
The patron would like to have legislation introduced substantially drafted, as attached. See the attached proposed draft resolution provided to the patron.

FISCAL IMPACT STATEMENT

Fiscal Impact	Yes ☐	No ☒
Budget Amendment Required	Yes ☐	No ☒
Estimated Cost or Revenue Impact	$ N/A	

Appendix C
2018 Greenhouse Gas Inventory

Appendix C: 2018 Richmond Greenhouse Gas Emissions Inventory

The purpose of this document is to quantify the City of Richmond's greenhouse gas emissions (GHG) for the year 2018 and present the methodology used to determine said quantification. This appendix includes a community-wide inventory followed by a government-specific inventory. Emissions are standardized as carbon dioxide equivalents (CO2e) based on their global warming potential (GWP). Table 2 presents this conversion for each greenhouse gas.

Figure 1 shows a 2018 emissions total of approximately 2,700,000 metric tons of CO2e (MTCO2e), a nearly 20% reduction from 2008.

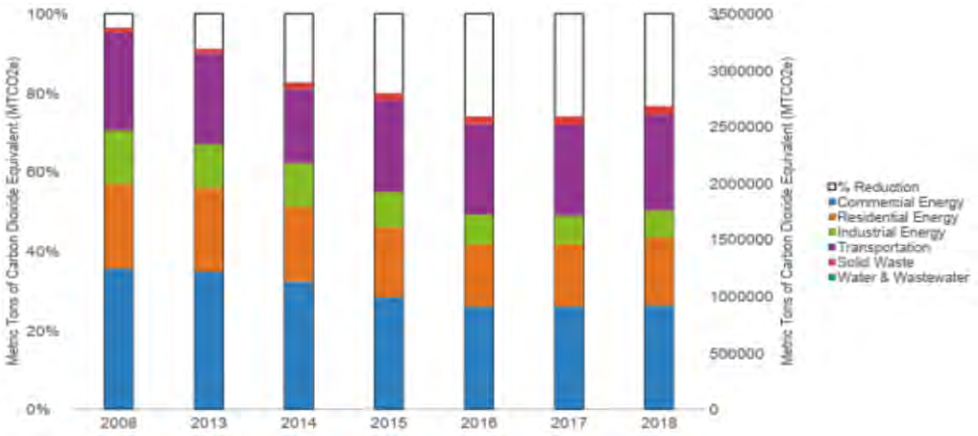


Figure 1. *Annual emissions reduction by sector, 2008 - 2018*

Table 1 provides a precise breakdown of greenhouse gas emission by sector, totaling 2,681,974 MTCO2e (2018).

	Inventory Year													
	2008		2013		2014		2015		2016		2017		2018	
Sector	CO2e	% Emissions	CO2e	% Emissions	CO2e	% Emissions	CO2e	% Emissions	CO2e	% Emissions	CO2e	% Emissions	CO2e	% Emissions
Commercial Energy	1,246,132	37%	1,216,813	38%	1,131,742	39%	992,602	35%	908,323	35%	908,944	35%	920,493	34%
Industrial Energy	471,065	14%	387,911	12%	383,941	13%	308,000	11%	255,942	10%	249,936	10%	237,551	9%
Residential Energy	748,875	22%	742,711	23%	663,792	23%	620,621	22%	557,085	22%	552,916	21%	601,295	22%
Solid Waste	43,050	1%	35,112	1%	59,481	2%	62,430	2%	64,438	2%	72,171	3%	72,171	3%
Transportation	866,165	26%	805,030	25%	652,488	23%	813,969	29%	803,903	31%	807,072	31%	849,407	32%
Water & Wastewater	2,046	0.06%	1,285	0.04%	1,927	0.07%	2,255	0.08%	1,282	0.05%	1,020	0.04%	1,057	0.04%

Table 1. Annual emissions by sector, 2008 - 2018

**Adapted from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5)*

Industrial designation or common name	GWP
Carbon dioxide	1
Methane	28
Nitrous oxide	265
Substances controlled by the Montreal Protocol	
CFC-11	4,660
CFC-12	10,200
CFC-13	13,900
CFC-113	5,820
CFC-114	8,590
CFC-115	7,670
Halon-1301	6,290
Halon-1211	1,750
Halon-2402	1,470
Carbon tetrachloride	1,730
Methyl bromide	2
Methyl chloroform	160
HCFC-21	148
HCFC-22	1,760
HCFC-123	79
HCFC-124	527
HCFC-141b	782
HCFC-142b	1,980
HCFC-225ca	127
HCFC-225cb	525
Hydrofluorocarbons (HFCs)	
HFC-23	12,400
HFC-32	677
HFC-41	116
HFC-125	3,170
HFC-134	1,120
HFC-134a	1,300
HFC-143	328
HFC-143a	4,800
HFC-152	16
HFC-152a	138
HFC-161	4
HFC-227ea	3,350
HFC-236cb	1,210
HFC-236ea	1,330
HFC-236fa	8,060
HFC-245ca	716
HFC-245fa	858
HFC-365mfc	804
HFC-43-10mee	1,650

Industrial designation or common name	GWP
Perfluorinated compounds	
Sulfur hexafluoride	23,500
Nitrogen trifluoride	16,100
PFC-14	6,630
PFC-116	11,100
PFC-218	8,900
PFC-318	9,540
PFC-31-10	9,200
PFC-41-12	8,550
PFC-51-14	7,910
PCF-91-18	7,190
Trifluoromethyl sulfur pentafluoride	17,400
Perfluorocyclopropane	9,200
Fluorinated ethers	
HFE-125	12,400
HFE-134	5,560
HFE-143a	523
HCFE-235da2	491
HFE-245cb2	654
HFE-245fa2	812
HFE-347mcc3	530
HFE-347pcf2	889
HFE-356pcc3	413
HFE-449sl (HFE-7100)	421
HFE-569sf2 (HFE-7200)	57
HFE-43-10pccc124 (H-Galden 1040x)	2,820
HFE-236ca12 (HG-10)	5,350
HFE-338pcc13 (HG-01)	2,910
HFE-227ea	6,450
HFE-236ea2	1,790
HFE-236fa	979
HFE-245fa1	828
HFE 263fb2	1
HFE-329mcc2	3,070
HFE-338mcf2	929
HFE-347mcf2	854
HFE-356mec3	387
HFE-356pcf2	719
HFE-356pcf3	446
HFE 365mcf3	<1
HFE-374pc2	627
Perfluoropolyethers	
PFPMIE	9,710
Hydrocarbons and other compounds - direct effects	
Chloroform	16
Methylene chloride	9
Methyl chloride	12
Halon-1201	376

Table 2. Global warming potential (GWP) values relative to CO2 for 100-year time horizon*

Community GHG Inventory

The chart below provides a breakdown of emissions sources in Richmond by reporting categories based on ICLEI'S ClearPath Tool.

Reporting Category	Emissions Sources
Residential Energy	• Fuel Oil • Electricity • Natural Gas
Commercial Energy	• Fuel Oil • Electricity • Natural Gas
Industrial Energy	• Fuel Oil • Electricity • Natural Gas
Transportation & Mobile Sources	• Gasoline • Diesel
Water & Wastewater	• Process Emissions • Digester Gas • Effluent Discharge • Septic Tanks
Solid Waste	• Solid Waste
Agriculture	N/A
Process & Fugitive Emissions	N/A
Upstream Impacts of Activities	N/A
Consumption Based	N/A

The methodology presented in this document is based on the ICLEI Community Protocol. It also builds upon and improves data collection and manipulation processes that were previously used by the City Of Richmond. As new data becomes available, we will update previous inventories to ensure we are providing the most accurate account of our emissions as possible.

Fuel Oil

Residential Fuel Oil

The methods and calculations presented in this document are estimates based on the ICLEI'S Community Protocol (Estimating Fuel Use in the Residential Sector p.13) and data availability. The data needed is listed below and is highlighted within the document. Data sources can be found in bold font throughout the document.

Key
Data Needed (highlighted)
Data Sources (bold)

Data needed

- Total number of households in Virginia
- Fuel oil used in Virginia
- Number of households in Richmond that use fuel oil

Methodology

Estimating fuel oil use in the residential sector involved the following steps:

1. The total number of households in Virginia that use fuel oil was obtained from the **Energy Information Administration (EIA)**.[1]

[1] As of May 9, 2019, the latest available data was 2009, which was released 3/28/11 with a final release in April 2013.

2. The estimated total number of barrels of fuel oil used in Virginia's residential sector was obtained from the **EIA's State Energy Data System**.[2] The number of barrels of fuel oil was converted into gallons.
3. The per-household energy use was calculated by dividing the total fuel oil used (gallons) in Virginia (step 2), by the total households in Virginia using fuel oil (step 1).
4. The number of households that use fuel oil in Richmond, Virginia was obtained using the **American Community Survey** data.[3]
5. The residential fuel oil use was calculated by multiplying per-household energy use (calculated in step 3) by the total number of households in Richmond that use fuel oil (step 4).

Data Collected (2015)

Data Point	Data Value	Source
Step 1. Total number of Households in Virginia that use fuel oil	0.1 million (100,000) households	https://www.eia.gov/consumption/residential/data/2009/#fueluses
Step 2. Fuel oil used in Virginia (2016 residential)	1,548 thousand barrels = 65,016,000 gallons	https://www.eia.gov/state/seds/sep_use/res/pdf/use_res_VA.pdf
Step 4. Total number of households in Richmond that use fuel oil (2017)	5,529 households	https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_16_1YR_DP04&prodType=table

Calculations/Data Manipulation

1. Total number of households

   0.1 x 1,000,000 = 100,000 households in Virginia that use fuel oil

2. Convert total barrels of fuel oil used to gallons (1 barrel = 42 gallons)

$$1,548,000\ barrels\left(\frac{42\ gallons}{1\ barrel}\right) = 65,016,000\ gallons$$

3. Calculate per-household energy use

$$\frac{65{,}016{,}000\ gallons}{100{,}000\ households} = 650.16\ gallons/household$$

4. Number of households in Richmond using fuel oil = 5,529

5. Calculate residential fuel oil

   650.16 gallons/household x 5,529 households = 3,594,734.64 gallons of fuel oil used

---

Source: **EIA -** Table HC1.10 Fuels Used and End Uses in Homes in the South Region, Divisions, and States 2009. This document is only available as an excel document. https://www.eia.gov/consumption/residential/data/2009/#fueluses
Please note: The units reported in this document "million housing units." Decimal values presented can be converted to whole numbers.

[2] **Source**: **EIA** – The 2016 residential fuel oil data was obtained on May 9, 2019. The data value represents thousand barrels in Virginia. The updates to this data were released on June 29, 2018 and June 28, 2019.
PDF: Table CT4. https://www.eia.gov/state/seds/sep_use/res/pdf/use_res_VA.pdf
Website: https://www.eia.gov/state/seds/seds-data-complete.php?sid=VA#Consumption Consumption-Sector-Residential (Virginia: 1960-2016)

[3] **Source: ACS** – Housing Physical Characteristics Heating Fuel. 2016 House heating fuel estimates were obtained on May 9, 2019 the latest available data is 2017
https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_15_1YR_DP04&prodType=table
Please note: The ACS does not separate fuel oil and kerosene. The number of households used in the calculation includes houses that use fuel oil and kerosene.
Please note: There is no available data for the number of households in Virginia that use kerosene via EIA. Because of a lack of household usage of kerosene for VA and Richmond, emissions from Kerosene usage has not been reported separately. Virginia's residential kerosene consumption was not added to the values in this document.

ClearPath Input

Fuel Type	Distillate Fuel Oil No. 2
Fuel Use	3,594,734.64 gallons
Data Source	Estimate using EIA usage
Number of Households	5,529

Commercial and Industrial Fuel Oil

The methods and calculations presented in this document are estimates based on the ICLEI'S Community Protocol (BE.1.3 Estimating Fuel Use in the Commercial Sector p.15) and data availability. The data needed is listed below and is highlighted within the document. Data sources can be found in bold font throughout the document. The ICLEI Protocol does not provide any guidance to calculate or estimate industrial fuel oil use.

Key
Data Needed (highlighted)
Data Sources (bold)

Data needed

- List of commercial buildings in Richmond based on inventory year
    - List should include year constructed, size, or primary usage
- Percentage of buildings in South Atlantic Region (SAR) using fuel oil
- Energy Intensity Factors

Methodology

Estimating fuel oil use in the commercial and industrial sector involved the following steps:

1. A list of commercial buildings within the City Of Richmond was obtained from the assessor's records. Buildings that were placed in the commercial category have primary uses that include education, health care, office, retail, and mixed use. Parking decks, parking garages, parking lots, and residential uses were removed from the list.[4]
2. The % of commercial buildings in the South Atlantic Region was calculated using EIA energy sources data. The number of buildings using fuel oil in Richmond was calculated using the % of commercial buildings in the South Atlantic Region using fuel oil.
   Source: EIA – Table B22. Energy sources number of buildings 2012
   https://www.eia.gov/consumption/commercial/data/2012/bc/pdf/b22.pdf
3. The commercial buildings were organized and classified by year constructed.
4. The total square footage of building space in each class was estimated.
5. The total fuel usage was calculated by applying the appropriate energy intensity factors from the EIA to each classification. The square footage of each category was multiplied by the energy intensity factor.
   Source: EIA – Table C35. Fuel oil consumption and conditional energy intensity by Census region
   https://www.eia.gov/consumption/commercial/data/2012/c&e/pdf/c35.pdf
6. Method BE.1.1 should be used to estimate commercial fuel oil use.

[4] The number of commercial buildings included in the 2016 inventory was 46% more than the amount that was included in the 2015 Inventory. Since the city of Richmond has a municipal utility, we used the tax assessor's office definition of commercial buildings, except where the description was clearly not a commercial use (ex. Residential and Industrial uses). Parking lots and parking decks/garages were excluded from this analysis because these locations are not likely to use fuel oil. The commercial use descriptions provided by the tax assessor's office was placed into the following primary use categories (education, health care, office, retail and other). Please review the commercial property descriptions tab in the 2016 Commercial Property Document. This method for categorizing commercial buildings was used for 2016-2018 GHG inventory.

Data Collected (2015)

Step 1. List of Commercial Buildings	Before 1945 = 2,971 1946-1979 = 1,990 1980-1999 = 870 2000-present = 500 Total commercial buildings = 6,331	Assessor's records
Step 2. Percentage of buildings using fuel oil in the SAR	Buildings using Fuel Oil = 69 thousand Total buildings = 1,091 thousand 6.32%	https://www.eia.gov/consumption/commercial/data/2012/bc/pdf/b22.pdf
Energy Intensity Factor (year constructed)	Before 1945 = 0.03 gal/yr 1946 –1979 = 0.03 gal/yr 1980 – 1999 = 0.02 gal/yr 2000 – 2012 = 0.03 gal/yr	https://www.eia.gov/consumption/commercial/data/2012/c&e/pdf/c35.pdf

Calculations/Data Manipulation

1. There were 6,365 commercial buildings in Richmond (category consist of land uses labeled as mixed use, commercial, and office)

2. Calculate percentage of commercial buildings in the South Atlantic Region that use fuel oil

$$\frac{69\ thousand}{1{,}091\ thousand} = 6.32\%$$

3. Calculate number of commercial buildings in Richmond that use fuel oil based on above percentage

$$6{,}331\ buildings * 6.32\% = 400.12\ commercial\ buildings$$

4. Estimate square footage in each class (*see spreadsheet for calculations)

5. Calculate Total Fuel Usage
   Equation:

$$6.32\%\ of\ Square\ Footage\ x\ Energy\ Intensity\ Factor = Total\ Fuel\ Use$$

Commercial Fuel Oil Use

Classification	Square footage	6.32% of Sq Ft	Energy Intensity Factor (gal/yr)	Total Fuel Use (gal/yr)
Before 1945	35,525,304	2,245,199.21	0.03	67,355.98
1946-1979	40,333,484	2,549,076.19	0.03	76,472.29
1980-1999	23,559,154	1,488,938.53	0.02	29,778.77
2000-2012	16,606,912	1,049,556.84	0.03	31,486.71
	116,024,854			205,093.74

ClearPath Input

Commercial Fuel Oil

Fuel Type	Distillate #2
Fuel Use	205,093.74
Data Source	US Community Protocol BE.1.3
Commercial Floor Area (1,000 Square Ft)	7,332 thousand
Number of Commercial Establishments	400

Industrial Fuel Oil Use

There is no methodology to calculate Industrial Fuel Oil Use. The EPA Flight Tool captures three large industrial facilities within the City of Richmond that use fuel oil. These establishments include Phillip Morris, VCU East Plant, and Bellemeade Power Plant. Phillip Morris reported 1.5 (Metric Tons) CO2 Emissions. The VCU East Plant and Bellemeade Power Plant are both power generating facilities. Emissions for these facilities were included in the Residential, Commercial and Industrial Electricity Emissions (per ICLEI staff). The information about emissions for these facilities are for information only and are not added to community's total emissions. VCU East Plant Emissions Bellemeade Power Plant Emissions

Electricity

The methods and calculations presented in this document are based on ICLEI's Local Government Protocol (BE.2.1 Emissions from Electricity Use p.17) and data availability.

Key
Data Needed (highlighted)
Data Sources (bold)

Data Needed

- Annual electricity use (kWh or MWh)
- Electricity emission factor(s)
- Number of Households (Residential)
- Population (Residential)
- Number of Commercial Establishments (Gov & non-Gov)

Methodology

Calculating GHG emission from electricity involved the following steps:

1. A list of all city electricity usage (kWh) was obtained from a representative at **Dominion Energy**. To provide additional insight into where the electricity is being used, city accounts were placed in the following categories:[5]
    a. Residential (include Richmond Redevelopment & Housing Authority Properties)
    b. Commercial (non-Gov + City-owned SMG operated properties)
    c. Commercial (Gov: COR, State and Fed- include Richmond Public Schools)
    d. Industrial
2. The number of households was obtained using the **Census Bureau's American Fact Finder**. Search Included:
    a. Topic or Table Name: Household
    b. Richmond City, VA
3. The emission factors were obtained from **EPA'S eGRID** (subregion: SERC Virginia/Carolina – SRVC)

Data Collected (2018)

2018 Final Numbers		
Category	**Accounts**	**Annual KWH**
Residential	98,074	1,149,743,337
Commercial	10,384	1,124,638,876

[5] Please review the 2018 Electricity Data spreadsheet to obtain additional information about the residential, commercial, and industrial sectors.

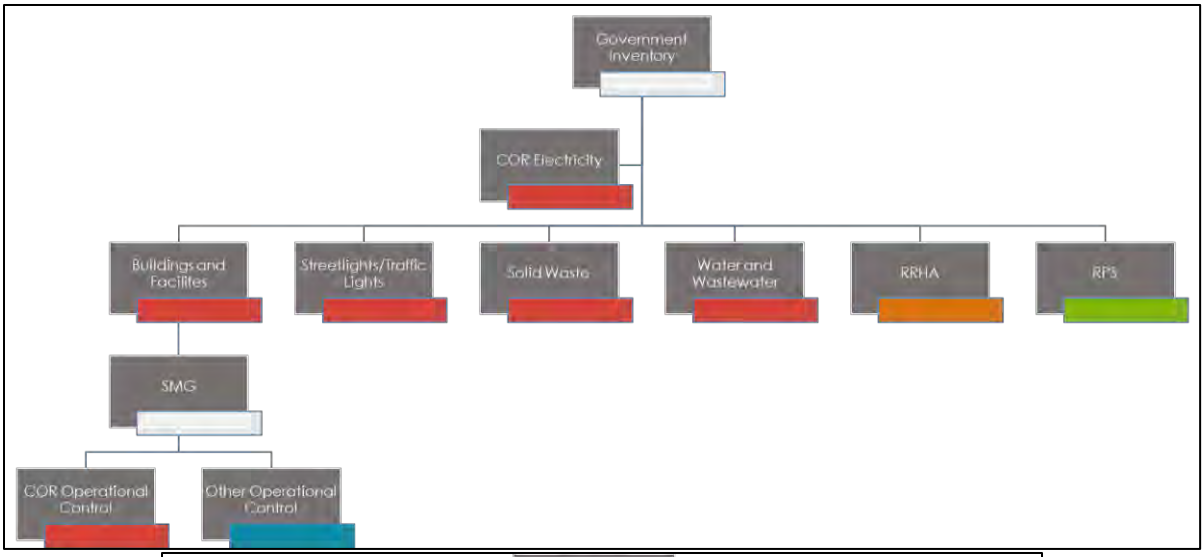
Governmental (Richmond)	511	174,018,611
Governmental (State & Fed)	816	563,847,920
Commercial Subtotal	11,711	1,862,505,407
Industrial	57	385,382,789
Total for 2018	**109,785**	**3,012,248,744**

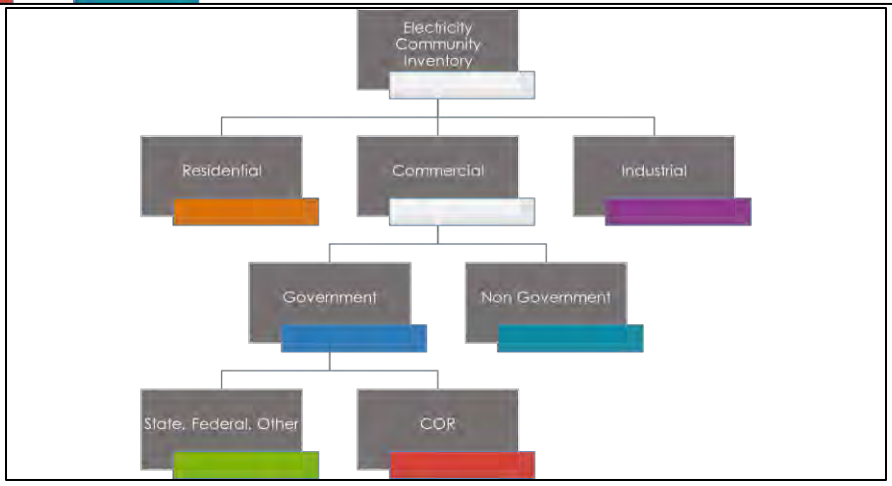
Additional Data Points	**2016 Data**	**Source**
eGRID subregion acronym: SRVC SERC Virginia/Carolina	*Total Output rates* CO_2 *= 805.3 lb/MWh* CH_4 *= 0.067 lb/MWh* N_2O *= 0.011 lb/MWh* CO_2e *= 810.1 lb/MWh*	https://www.epa.gov/sites/production/files/2018-02/documents/egrid2016_summarytables.pdf
Households (2017 1-year estimate)	*87,401*	https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_17_1YR_S2504&prodType=table

Data Calculation/Manipulation

Electricity

1. **Residential**
   - Dominion Reported Residential
   - RRHA – Reported by Dominion under COR government usage
2. **Commercial**
   - **Non Government**
     - Dominion Reported Non-government building
     - SMG- Owned by COR, Operated/Manged by SMG (Altria Theater -3 accounts)
   - **Government**
     - Dominion Reported State and Federal Government Electricity Use
     - City of Richmond Electricity Use
       - SMG- Reported by Dominion under COR government usage 3 account are under COR operational control. These values are already included in the City of Richmond values
     - Richmond Public Schools Electricity Use
3. **Industrial**
   - Dominion Reported Industrial Electricity Use





ClearPath Input

Residential

Grid Electricity	*Egrid (2016)*
Electricity Used	1,149,743,337 KWH
Number of Households	*87,401*
Population	*223,170*

Commercial (non-Gov)

Grid Electricity	*Egrid (2016)*
Electricity Used	1,124,638,876 KWH
Commercial Floor Area	N/A
Number of Commercial Establishments	*N/A*

Commercial Government (COR, State & Fed)

Grid Electricity	*Egrid (2016)*
Electricity Used	737,866,531 KWH
Commercial Floor Area	N/A
Number of Commercial Establishments	*N/A*

Industrial

Grid Electricity	*Egrid (2016)*
Electricity Used	385,382,789 KWH

Natural Gas

Key
Data Needed (highlighted)
Data Sources (bold)

Data Needed

- Natural gas usage
- Number of households
- Conversion factor

Methodology

Estimating the emission from natural gas usage involved the following steps:

1. Natural gas usage (reporting unit ccf) was obtained from Dept. Public Utilities/Dept. Information Technology for the following sectors:[6]
    a. Residential
    b. Commercial (non-Gov) – Commercial Service Class
    c. Commercial (Gov) – Municipal Service Class
    d. Industrial – Industrial Service Class[7]

    Source: Jayson Patterson, DPU/DIT
2. The conversion factor (CCF/MCF to MMBTU) is based on annual natural gas purchases The conversion factor was based on the national average
    Source: EIA
    https://www.eia.gov/dnav/ng/ng_cons_heat_a_EPG0_VGTH_btucf_a.htm
3. Data was entered into Clearpath

Data Collected (2018)

Data Point	Data Value	Data Source/Contact
Natural Gas Usage	Community Report • Residential = 25,749,837.67 ccf • Commercial (non-Gov) = 39,200,862 ccf • Commercial Gov (Fed, State) = 1,362,331 ccf • Industrial FL = 552,083 • Industrial IN = 16,896,678 ccf SMG Report = 319,696 ccf COR Report = 1,585,495 ccf	DPU/DIT Jayson Patterson Carrsandra Hull
Number of Households	87,401[8] households in Richmond 34,343 households using utility gas	American Fact Finder
Conversion Factor	2018 Data US: 1 MCF = 1.036 MMBTU VA: 1 MCF = 1.052 MMBTU	EIA https://www.eia.gov/dnav/ng/ng_cons_heat_a_EPG0_VGTH_btucf_a.htm

[6] The 2018 request for data differed from the previous data request (2015). 2015 natural gas consumption was reported based on the charge date. The 2016 and subsequent natural gas consumption data was reported based on date of consumption (meter readings). In 2015 the flexible interruptible accounts were calculated in the commercial sector, however, this information is reported in the industrial sector according to DPU/DIT. In this 2018 inventory, the flexible interruptible accounts were applied to the industrial sector. SMG and City of Richmond Accounts were excluded from all data values reported as Municipal service class (commercial gov). COR and SMG (COR operational control) natural gas usage data from the local government inventory was added to the commercial gov sector. SMG accounts that are not in COR operational control were included in commercial non-government. The data manipulation/conversion of ccf to mmbtu for the COR and SMG data can be found in the government natural gas methodology. (see other calculations in the 2018 Community Natural Gas Data spreadsheet)

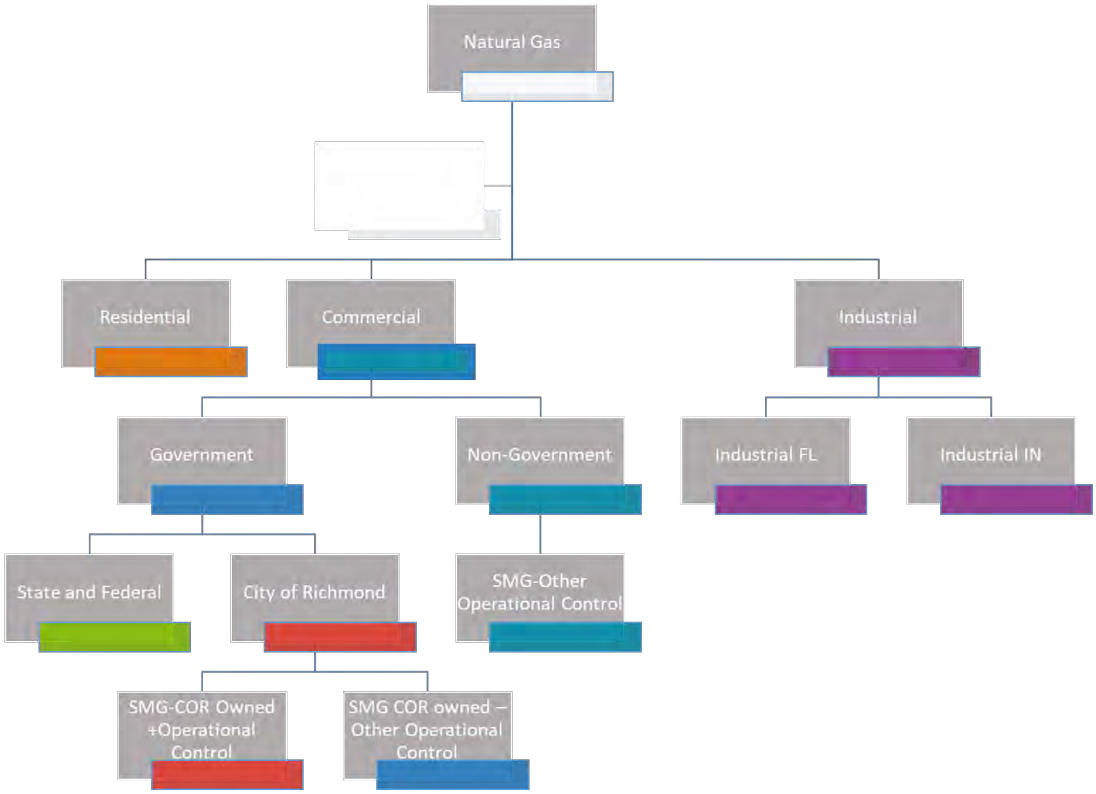
[7] The natural gas utility can separate gas used for heat and process by industrial customers.

[8] Number of households value is based on 2017 data because 2018 data was not available at the time of inventory calculation. This data should be updated when data becomes available.

Data Manipulation/Calculation

The data collected was categorized as follows for the purpose of the inventory.

- Residential
- Commercial government - This subsector includes state, federal, and municipal (COR accounts) commercial buildings. It also includes municipal (COR) owned buildings that are operated by SMG.
- Commercial non-government – This subsector includes non-government commercial buildings and SMG operated buildings that are not owned by the City of Richmond (Dominion Energy Center)
- Industrial- This subsector includes industrial buildings and buildings with flexible interruptible accounts.



Residential

$$25,749,837.67\ ccf\left(\frac{1\ mcf}{10\ ccf}\right)\left(\frac{1.036\ mmbtu}{1\ mcf}\right)$$

$$= \ 2,667,683.18\ MMBTU$$

Commercial non-government

Other owned+SMG operated[9]	36,258 ccf
Commercial (non-gov)	39,200,862 ccf

$$39,237,120\ ccf\left(\frac{1\ mcf}{10\ ccf}\right)\left(\frac{1.036\ mmbtu}{1\ mcf}\right)$$

$$= 4,064,965.63\ MMBTU$$

[9] This represents natural gas usage from Dominion Energy Center. The Dominion Energy Center is not owned or operated by the City of Richmond; therefore natural gas usage from this facility should be allocated to the commercial non-government sector. These values should be included in the commercial non-government sector.

Commercial government

State and Federal	1,362,331 ccf
City of Richmond	1,773,991 ccf
COR owned + SMG operated	94,942.00 ccf

$$3,231,264\ ccf\left(\frac{1\ mcf}{10\ ccf}\right)\left(\frac{1.036\ mmbtu}{1\ mcf}\right)$$

Industrial

$$17,448,761\ ccf\left(\frac{1\ mcf}{10\ ccf}\right)\left(\frac{1.036\ mmbtu}{1\ mcf}\right)$$

$$= 1,807,691.64\ MMBTU$$

Clearpath Input

Residential

Fuel Type	Natural Gas
Fuel Use	2,667,683.18 MMBTU
Number of Households	34,343

Commercial (non-Gov)

Fuel Type	Natural Gas
Fuel Use	*4,064,965.63* MMBTU

Commercial (Gov)

Fuel Type	Natural Gas
Fuel Use	*334,758.95* MMBTU

Industrial

Fuel Type	Natural Gas
Fuel Use	1,807,691.64 MMBTU

Transportation

The methods and calculations presented in this document are based on ICLEI's US Community Protocol (TR.1 Emissions from Passenger Vehicles) and data availability.

Key
Data Needed (highlighted)
Data Sources (bold)

Data Needed

- Daily Vehicle Miles Traveled (VMT)
- Transportation Factors

Methodology

Estimating emissions from transportation involved the following steps:

1. The daily vehicle miles traveled (All Roads) data for federal vehicle class 1-13 were obtained from the **Virginia Department of Transportation (VDOT) 1220 Report** for the City Of Richmond
2. Vehicles were separated based on Vehicle Class and assumptions of fuel use were made. See table below:

Class	*Fuel Type*
1-3	Gasoline
4-13	Diesel

3. Annual Vehicle Miles Traveled (AVMT) for each fuel type calculated from daily values
4. Transportation factors (fuel efficiency and emissions) were obtained
5. Data was entered into Clearpath

Data Collected (2018)
**These values have decimals that are captured in the Master Data Workbook*

Federal Vehicle Class		**DVMT**
01	Motorcycles	**7,693**
02	Passenger Cars	**4,490,044**
03	Two Axle, 4 Tire Single Unit Vehicles	**695,849**
04	Busses	**34,979**
05	Two Axle, 6 Tire Single Unit Trucks	**32,150**
06	Three Axle Single Unit Trucks	**20,072**
07	Four or More Axle Single Unit Trucks	**3,314**
08	Four Axle or Fewer Single Trailers	**12,422**
09	Five Axle Single Trailers	**91,668**
10	Six or More Axle Single Trailers	**1,459**
11	Five Axle or Fewer Multi-Trailers	**3,678**
12	Six Axle Multi-Trailers	**2,243**
13	Seven or More Axle Multi-Trailers	**30**
		5,395,600

Data Calculation/Manipulation

Calculate AVMT

Daily VMT*365=AVMT

Gasoline (Class 1-3)

$$5{,}193{,}585 * 365 = 1{,}895{,}658{,}515.15$$

Diesel (Class 4-13)

$$202{,}015 * 365 = 73{,}735{,}477.97$$

Determine % VMT of each class (Gasoline). Please see spreadsheet for calculations

$$\%\ VMT\ (Class\ 1) = \frac{Class\ 1}{Sum\ of\ Class\ 1-3}$$

$$\%\ VMT\ (Class\ 2) = \frac{Class\ 2}{Sum\ of\ Class\ 1-3}$$

$$\%\ VMT\ (Class\ 3) = \frac{Class\ 3}{Sum\ of\ Class\ 1-3}$$

Clearpath Input

Gasoline

Calculation Method	VMT & MPG
VMT Location	In Boundary
Travel Type	Passenger
Fuel Type	Gasoline
VMT	1,895,658,515.15
Percent	Motorcycles = 0.15% Passenger = 86.45% Light Duty = 13.40% Heavy Duty = 0%

Diesel

Calculation Method	VMT & MPG
VMT Location	In Boundary
Fuel Type	Diesel
VMT	73,735,477.97
Percent	Motorcycles = 0% Passenger = 0% Light Duty = 0% Heavy Duty = 100%

Water and Wastewater

The methods and calculations presented in this document are based on ICLEI's US Community Protocol (Appendix F: Water and Wastewater Emissions Activities and Sources) and data availability.

Key
Data Needed (highlighted)
Data Sources (bold)

Data Needed

- Process Emissions
  - Population estimate
  - Industrial discharge multiplier
- Digester Gas
  - Methane production
  - Fraction of methane in digester gas
  - Destruction efficiency
- Effluent Discharge
- Septic Tanks
  - Number of septic tanks
  - Occupied housing units
  - Population estimate

Methodology

Estimating the emissions generated from process emission involved the following steps:

1. The population estimate obtained from the **American Community Survey (Census)**
2. The industrial discharge multiplier default value (1.25) was obtained from the **ICLEI Protocol**
3. Data was entered into Clearpath

Estimating the emissions generated from digester gas involved the following steps:

1. Methane production data was obtained from the **Department of Public Utilities**
   This data was reported in standard cubic ft per year and was converted to standard cubic ft per day
   Source: Ed Edmondson, DPU
2. The fraction of methane in digester gas default value and the destruction efficiency were obtained from the **ICLEI Protocol**
3. Data was entered into Clearpath

Estimating the emissions generated from effluent discharge involved the following steps:

1. The daily nitrogen discharge was obtained from the **Department of Public Utilities**
   This data was reported as lbs per year and was converted to kg per day
   Source: Ed Edmondson, DPU
2. Data was entered into Clearpath

Estimating the emissions generated from septic tanks involved the following steps:

1. An approximate number of septic tanks within Richmond was obtained from the **Department of Utilities**
   Source: Ed Edmondson, DPU
2. The estimated occupied housing units and total population data were obtained from the **American Community Survey (Census)**
3. The number of people served by septic tanks was estimated using population and septic tank data
4. Data was entered into Clearpath

Data Collected (2018)

Process Emission

Population Estimate	227,032	American Community Survey (Census)
Industrial Disharge Multiplier	1.25 (default)	ICLEI Protocol

Digester Gas

Methane (CH4) Production	52.6 million scf/year (standard cu ft per year)	Department of Public Utilities Ed Edmondson
Fraction of Methane in Digester Gas	0.65 (default)	ICLEI Protocol
Destruction Efficiency	0.99 (default)	ICLEI Protocol

Effluent Discharge

Daily Nitrogen Discharge	351,864 lbs/year	Department of Public Utilities Ed Edmondson

Septic Tanks

Number of Septic Tanks	61	Department of Public Utilities - Ed Edmondson
Occupied Housing Units	87,401	American Community Survey (Census)
Population	227,032	American Community Survey (Census)

Data Manipulation/Calculation

Digester Gas: Convert scfm to scf per day

$$52.6\ million\ scf/year\ (\frac{1\ year}{365\ days})$$

$$= 144,109.59 \frac{scf}{day}$$

Effluent Discharge: Convert lbs/day to kg/day

$$351,864 \frac{lb}{year}\left(\frac{0.454kg}{1lb}\right)\left(\frac{1year}{365days}\right)$$

$$= 437.66 \text{ kg/day}$$

Septic Tanks: Estimate how many people are served by the septic tanks

$$\frac{227{,}032\ ppl}{87{,}401\ occupied\ housing\ units}$$

$$= 2.60\ ppl\ per\ household$$

$$Persons\ served\ by\ septic\ tanks = Ppl\ per\ house * \#\ of\ Septic\ tanks$$

$$= 2.59\ ppl\ per\ house * 61\ septic\ tanks$$

$$= 158.45\ people\ served\ by\ septic\ tanks$$

Clearpath Input

Process Emission (Nitrification/Denitrification Process N20 Emissions from Wastewater Calculator)

Nitrification/Denitrification as a step in the treatment process	Yes
Population Served	227,032
Industrial Discharge Multiplier	1.25
Wastewater Generation and Treatment	Generated and treated in boundary

Digester Gas (Incomplete combustion of digester gas - Quantity of flared gas and related data calculator)

Site Specific or Population Based	Site Specific
Digester Gas Produced	$144,109.59 \frac{scf}{day}$
Fraction of Methane	.65
Destruction Efficiency	.99
Wastewater Generation and Treatment	Generated and treated in boundary

Effluent Discharge (Process N2O from Effluent Discharge to Rivers and Estuaries)

Do you have daily N load data from your effluent discharge	Yes
Daily N Load	437.66 kg/day
Population Served	227,032
Wastewater Generation and Treatment	Generated and treated in boundary

Septic Tanks (Fugitive Emissions from Septic System)

Calculation Type	Population Based
Population Served	*158.45 ppl*

Solid Waste

The methods and calculations presented in this document are based on ICLEI's Local Government Protocol (SW.4 Community Generated Waste Emissions p.22) and data availability. Richmond's waste is sent to a landfill outside of the city's boundaries.

Key
Data Needed (highlighted)
Data Sources (bold)

Data Needed

- Mass of waste from the community entering the landfill
- Each landfill that accepts waste from the community had a landfill gas collection and control system in place
- Waste characterization (if not available, use defaults)
- Number of households
- Number of businesses
- Disposal location
- Waste characterization

Methodology

Estimating the community generated waste emissions of MSW involved the following steps:

1. Mass of waste entering the landfill was collected from **Waste Management**
    - Mass was reported in tons and was placed in 3 categories (chargeable, residents, waste management, non-waste management)[10]
    - The total tons of solid waste was obtained by adding the values of the categories.
2. # of households obtained using the **Census Bureau's American Fact Finder** search:
    - Topic or Table Name: Household
    - Richmond City, VA
3. The default waste characterization factor was obtained from **ICLEI's Protocol**.
4. Data was input into clear path

Data Collected (2018)

Step 1. Mass of Solid Waste	Total tons = 196,298.818 *see tables below	Waste Management Audrey Strange
# of Households in Richmond	87,401	American Fact Finder https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_15_1YR_S1101&prodType=table

Data Calculations/Manipulation

Month	Residents	City Trash	**Total Tons**
January	1019	5788	6807
February	1283	5938	7221
March	1587	6402	7989
April	1713		8620
May	1843		9500
June	1800		9322
July	1878		8684
August	1824		9269
September	1644		8096
October	1836		7636
November	1600		8505
December	1218		6865
Total Tons			**98514**[11]

[10] In December 2016, Waste Management started a new contract with the city of Richmond no longer accepting waste from private haulers. The waste produced in December was estimated based on the average waste produced over the other 11 months of 2016. Royalty tons consist of WM and non-WM. Total City consists of Chargeable and Residents. Estimated waste produced in 2016 was used to determine the difference in waste produced in 2018.

[11] The total tons collected at the transfer station does not include waste from private haulers (private hauler waste was no longer accepted at the transfer station after December 2016). In order to estimate waste production in

Annual waste produced in 2016 = 196,298.8 tons
196,298.8 tons – 98,514 tons = 97,784.818 tons

2018 estimated tonnage =196,298.8 tons

Waste from the City of Richmond's Municipal Operations

DPW Facilities

Month	Estimated Tons
September	126.938
October	129.83
November	132.89624
December	131.822
January	179.92
February	155.666
March	135.674
April	137.286
May	146.978
Average waste production per month	**141.89**
Estimated Annual Waste Production	**1702.68**

Estimated Annual Waste- Park & Rec 243.984 tons

COR Waste = DPW Facilities + Parks & Recreation
Total Community Waste = WMReported Waste + DPW Facilities + Parks & Rec
=196,298.82+1702.68+243.984
=198,245.48 tons

Clearpath Input

Waste Management Reported Waste

Waste Characterization	EPA ICLEI
Total Waste Generated	196,298.82 tons
Does the receiving landfill have methane collection?	Yes
Disposal Location	Outside Jurisdiction
Number of Households	87,401

DPW Facilities and Park & Rec

Waste Characterization	EPA ICLEI
Total Waste Generated	1946.66 tons
Does the receiving landfill have methane collection?	no
Disposal Location	Outside Jurisdiction

Government GHG Inventory

The chart below provides a breakdown of emissions sources in Richmond by reporting categories based on ICLEI's ClearPath Tool.

Richmond, the difference between 2016 and 2018 values were calculated. The difference was then added to the reported waste production.

Reporting Category	Emissions Sources
Buildings & Facilities includes stationary (6.1) and fugitive (6.6) emissions as well as Scope 2 emissions (6.2-6.4.2). All stationary, fugitive, and Scope 2 emissions not included in any other sector below should be included in this sector. Typically this will include administrative facilities, public venues, libraries, parks and recreational facilities, storm water pumping, storage facilities, etc.	● Electricity ● Fuel Oil ● Natural Gas ● Fugitive Emissions (6.6.2.2)
Streetlights & Traffic Signals includes Scope 2 emissions from electricity (6.2) related to these types of lighting, including crosswalk signals and amber flashers. Other outdoor lighting that can be segregated from the facilities that it serves can be included in this sector rather than in the buildings and other facilities sector – often times the outdoor lighting at a given building is provided for by the same meter as the rest of the facility and in these cases it should be reported in buildings and other facilities.	● Electricity
Vehicle Fleet includes mobile combustion (7.1 and 7.2) and fugitive emissions (7.4) as well as Scope 2 emissions from purchased electricity (7.3) for all electric vehicles and other electrified mobile equipment operated by the local government. Note that all vehicles should be reported here or under transit below rather than in the sector with which their use is associated (i.e. vehicles used at the solid waste disposal facility should be reported with the vehicle fleet and not in the solid waste disposal facilities sector). Typically this will include cars, trucks, vans, heavy equipment, boats, planes, helicopters, tractors, backhoes, etc. Reference: Chapter 7	● CNG ● Gasoline ● Diesel ● HFC-134a fugitive emissions from mobile AC
Employee Commute	● Gasoline ● Diesel ● CNG
Solid Waste Facilities includes stationary (6.1) and fugitive (10 and 6.6) emissions as well as Scope 2 emissions (6.2-6.5) related to local government owned/operated disposal facilities.	● Electricity ● Solid Waste
Water & Wastewater Treatment Facilities **Water Delivery Facilities** includes stationary (6.1) and fugitive (6.6) emissions as well as Scope 2 emissions (6.2-6.5) related to any facilities used for the transportation, treatment, or distribution of drinking water. Typically this will include treatment facilities, booster stations, lift stations, in-line pumps, storage facilities, and reservoirs. **Wastewater Facilities** includes stationary (6.1) fugitive and process (6.6 and 10) emissions as well as Scope 2 emissions (6.2-6.5) related to any facilities used for the transportation, collection, or treatment of wastewater/sewage. Typically this will include treatment facilities, booster stations, inline pumps, and lift stations.	● Electricity ● Fuel Oil ● Propane ● Natural Gas
Other Process & Fugitive Emissions should include emissions from natural gas system leaks where the government operates the transmission system and other process and fugitive emissions discussed in Chapter 11.	● HCFC-22 ● HFC-407C ● HFC-410A ● HFC-134a Fleet Refrigerant

The methodology presented in this document is based on the ICLEI Community Protocol. It also builds upon and improves data collection and manipulation processes that were previously used by the City Of Richmond. As new data becomes available, we will update previous inventories to ensure we are providing the most accurate account of our emissions as possible.

Based on the Local Government GHG Inventory Protocol, the City Of Richmond's organizational boundaries were established using the approach for Operational Control (plus facilities that the government has significant influence over). This inventory includes all government operated facilities, streetlights, traffic signals, and other stationary sources; process emissions from wastewater treatment; emissions from the city's on-road vehicle fleet and off-road equipment; municipal solid waste disposal; and emissions from employees commuting to work. This does not include Richmond Public Schools.

Electricity

The methods and calculations presented in this document are based on ICLEI's Local Government Protocol (6.2.1) and data availability.

Key
Data Needed (highlighted)
Data Sources (bold)

Data Needed

- Annual electricity use (kWh or MWh)
- Electricity emission factor(s)

Methodology

Calculating Government GHG emissions from electricity involved the following steps:

1. A list of all city accounts with annual electricity usage (kWh) was obtained from a representative at **Dominion Energy**. To provide additional insight into where the electricity is being used, city accounts were placed in the following subdivisions/sectors based on their rate schedules:[12]
    a. Buildings & facilities (All accounts that are not in the categories below were placed in this category)[13]
    b. Street & traffic lights[14] (Rate 155 Sch 154 and Rate 144 Sch 102)
    c. Water & Wastewater Treatment Facilities (Rate 147 Sch 120)
    d. Solid Waste Facilities

    *Note: Include account number to ensure each entry is unique.[15]
2. The emission factors were obtained from **EPA'S eGRID**[16] (subregion: SERC Virginia/Carolina – SRVC)
    Source: EPA – Subregion Emissions – Greenhouse Gases (eGRID2016v2)

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[12] Rate schedules were used to initially identify streetlights and traffic lights and wastewater and water treatment facilities. The address of water and wastewater treatment facilities and solid waste facilities was used as a secondary identification to allocate electricity use to the correct sector. In speaking with Calyn from ICLEI, in cases of solid waste and water/wastewater treatment facilities, it was found that most cities do not separate building energy emissions from process energy emissions.

[13] Richmond Public Schools (RPS) and Richmond Redevelopment and Housing Authority accounts should not be included in the Government Inventory. RPS electricity use should be included in the Community Inventory under Commercial Government. RRHA should be included in the Community Inventory under the Residential Sector. In 2015 all SMG accounts were included in the Government Inventory. The Dominion Energy Center is not listed as being owned or operated by the City of Richmond; therefore data for this facility could not be obtained from the Electric Utility. Since the COR does not have operational or financial control over this facility it should not be included in the Government Inventory. The Altria Theater is listed as a City of Richmond owned facility; however, since it is operated by SMG, it should not be included in the Government Inventory because this inventory is based on operational control. LGO Protocol p.14: "A local government accounts for 100% of the GHG emissions from operations over which it has control. It does not account for GHG emissions from operations in which it owns an interest, but has no control."

[14] According to Section 13.1.2.1, streetlights and traffic lights include Scope 2 emissions from electricity related to these types of lighting, including crosswalk signals and amber flashers. Other outdoor lighting that can be segregated from the facilities that it serves can be included in this sector rather than building and other facilities sector – often times the outdoor lighting at a given building is provided for by the same meter as the rest of the facility an in these cases it should be reported in buildings and other facilities.

[15] Account numbers can be provided by the electric facility.

[16] eGRID values should be checked/updated every 2 years. This inventory uses 2016 Egrid values.

https://www.epa.gov/sites/production/files/2017-02/documents/egrid2014_summarytables_v2.pdf

3. The annual emissions in metric tons of carbon dioxide equivalent was determined by entering annual usage for each sector into ClearPath

Data Collected (2015)

Step	Data	Contact
Step 1. Electricity Usage	Buildings & Facilities = 98,402,956 kWh Streetlights = 7,857,846 kWh Traffic Lights = 192,042 kWh Solid Waste = 40,034 kWh Water & Wastewater Treatment = 67,525,733 kWh	Dominion Energy Key Account Manager: Adam Birdsong
Step 2. Emission Factors	Subregion Output Emission Rates: SRVC Carbon dioxide (CO_2) = 805.3 lb/MWh Methane (CH_4) = 0.067 lb/MWh Nitrous Oxide (N_2O) = 0.011 lb/MWh	https://www.epa.gov/sites/production/files/2018-02/documents/egrid2016_summarytables.pdf

ClearPath Input
Data was entered into ClearPath as listed in the chart above.

Natural Gas

The methods and calculations presented in this document are based on ICLEI's Local Government Protocol (6.1.1) and data availability.

Key
Data Needed (highlighted)
Data Sources (bold)

Data Needed

- Annual Natural Gas Use
- National Annual Natural Gas Purchase (conversion factor)

Methodology
Calculating Government GHG emissions from natural gas involved the following steps:

1. A list of all City of Richmond accounts with Natural Gas usage was obtained from a representative from the **Department of Information Technology (DIT)**[17]. To provide additional insight into where the natural gas is being used, city accounts were placed in the following subdivisions/sectors:[18] Water and wastewater treatment facilities were identified using the addresses from previous inventory.
    a. Buildings & facilities[19]

[17] In previous inventories (2015 and prior), EnergyCAP was used to identify local government natural gas usage. At the time of data collection, EnergyCAP data was not available and all data was provided by DIT. The data in this inventory was based on the date of natural gas consumption.

[18] The 2015 Master Data Sheet (MDS) was used to segment accounts into the 3 sectors based on their account number and address. These addresses for the water and wastewater treatment facilities were identified using the 2015 MDS and used to identify these accounts in this inventory.

[19] Facilities that are managed by SMG were included in the buildings and facilities in prior inventories (2015 and prior). This inventory is based on operational control and the COR does not have operational control over all SMG accounts. The city has operational control over the Coliseum and Washington training center, which are included in this inventory. Altria Theater is owned by COR but is operated by SMG and should not be included. Dominion Energy Center is neither owned nor operated by COR.

b. Water Treatment & Delivery
    - 3920 Douglasdale
    - Cofer Rd Pump Station
c. Wastewater Treatment Facilities
    - 1400 Brander St[20]

2. Natural gas data was reported in CCF and was converted to MMBtu. The conversion factor was obtained from the EIA's National Annual Natural Gas purchase[21]
   Source: EIA – Heat Content of Natural Gas Consumed
   https://www.eia.gov/dnav/ng/ng_cons_heat_a_EPG0_VGTH_btucf_a.htm
   *Note that this conversion factor can change annually
3. The annual emissions in metric tons of carbon dioxide equivalent was determined by entering annual usage for each sector into ClearPath

Data Collected (2018)

Step 1. Natural Gas Usage	Buildings & Facilities = 13,44,706 CCF Water Treatment & Delivery = 21,137 CCF Wastewater Treatment = 332,103 CCF	DIT/DPU Jayson Patterson
Step 2. Conversion Factor	1 ccf = 1/10 mcf 1 mcf = 1.036 mmbtu OR 1 ccf = 100 cubic ft 1 cubic foot = 1,036 BTU (EIA) 1 BTU = 0.000001 MMBtu 1 mcf = 1.036 mmbtu 1 cubic foot = 0.001 mcf	https://www.eia.gov/dnav/ng/ng_cons_heat_a_EPG0_VGTH_btucf_a.htm

Calculations/Data Manipulation

Buildings and Facilities

$$1,344,706\ CCF\left(\frac{100\ CF}{1CCF}\right) = 134,470,600\ CF$$

$$134,470,600\ CF\left(\frac{1{,}036\ BTU}{1\ CF}\right) = 1.39312\ x\ 10^{11}\ BTU$$

$$1.39312\ x\ 10^{11}\ BTU\left(\frac{.000001\ MMBTU}{1\ BTU}\right) = 139311.54\ MMBTU$$

Water Treatment and Delivery

$$21,137\ CCF\left(\frac{100\ CF}{1CCF}\right) = 2,113,700\ CF$$

$$2,113,700\ CF\left(\frac{1{,}036\ BTU}{1\ CF}\right) = 2,189,793,200\ BTU$$

$$2,189,793,200\ BTU\left(\frac{.000001\ MMBTU}{1\ BTU}\right) = 2,189.79\ MMBTU$$

[20] There are multiple accounts that appear under the address 1400 Brander Street. These values were summed and placed in the wastewater facility sector.

[21] The conversion factor can change annually so this conversion factor should be based on annual natural gas purchases. The overall U.S. purchases were used, although the VA state's purchase data was available.

Wastewater Treatment Facilities

$$332,103\ CCF\left(\frac{100\ CF}{1\ MCF}\right) = 33,210,300\ CF$$

$$33,210,300\ CF\left(\frac{1{,}036\ BTU}{1\ CF}\right) = 34,405,870,800\ BTU$$

$$34,405,870,800\ BTU\left(\frac{.000001\ MMBTU}{1\ BTU}\right) = 34,405.87\ MMBTU$$

ClearPath Input

Buildings and Facilities	139,311.54 MMBTU
Water Treatment and Delivery	*2,189.79* MMBTU
Wastewater Treatment	*34,405.87* MMBTU

Fuel Oil

The methods and calculations presented in this document are based on ICLEI's Local Government Protocol (6.1.1) and data availability.

Key
Data Needed (highlighted)
Data Sources (bold)

Data Needed

- Annual Fuel Oil Usage (gallons)

Methodology

Calculating Government GHG emissions from fuel oil involved the following steps:

1. Fuel oil usage data for City departments was estimated by using fuel oil purchases for calendar year 2016. This data was obtained from **James River Solutions (JRS)** and **Woodfin**. Woodfin reported fuel oil for wastewater treatment facilities (only). To provide additional insight into where the fuel oil is being used, city accounts were placed in the following subdivisions/sectors:[22]
    a. Buildings & facilities
    b. Water Treatment & Delivery/Wastewater Treatment Facilities

2. The annual emissions in metric tons of carbon dioxide equivalent was determined by entering annual fuel oil purchases for each sector into ClearPath using the "Emissions from Stationary Fuel Combustion" calculator

Data Collected (2015)

Fuel Oil Purchases JRS	Buildings: 6503.6 gallons Water Treatment: 2153.5 gallons	James River Solutions Bridget Bailey
Fuel Oil Purchases Woodfin	Buildings and Facilities: 465.7 gallons Water Treatment: 220.2 gallons Wastewater Treatment: 442.5 gallons	Woodfin Lisa Daniel

[22] In previous inventories (2015 and prior), all data from James River Solutions was placed under buildings and facilities. In 2018, James River Solutions provided fuel oil purchase data based on sectors (Building and Facilities and Water Treatment). The fuel oil purchases from JRS and Woodfin were allocated to their appropriate sectors and values were summed accordingly.

Calculations/Data Manipulation
Buildings and Facilities
James River Solutions + Woodfin data

6503.6 + 465.7 =6969.3 gallons

Water & Wastewater
James River Solutions (Water Treatment) + Woodfin Oil (Water) = Total
2,153.5 gallons+220.2 gallons=2,373.7 gallons

Wastewater Treatment (Woodfin)
= = 442.5 gallons

ClearPath Input

Buildings and Facilities	6969.3 gallons
Water Treatment and Delivery & Wastewater Treatment Facilities	2,379.7 gallons
Wastewater Treatment	442.5 gallons

Vehicle Fleet

The methods and calculations presented in this document are based on ICLEI's Local Government Protocol (7.1.1) and data availability.

Key
Data Needed (highlighted)
Data Sources (bold)

Data Needed
- Inventory of all Active Fleet Vehicles
  - Unit Number
  - Vehicle Make
  - Vehicle Model
  - Annual Vehicle Miles Traveled
  - Annual Fuel Usage
  - Type of Fuel
- Inventory of the Fleet Vehicle for the Calendar Year
  - Unit Number

Methodology
Calculating Government GHG emissions from fleet involved the following steps:
All Active On Road Vehicles

1. An iinventory of all active on-road fleet vehicles was obtained from the **Vehicle Fleet Department** - make and model was used to separate vehicles into 3 types (passenger, light duty vehicles, and heavy duty vehicles) based on the following criteria[23]
   Passenger Vehicles: Class 1 & 2 Vehicles from FHWA
   Examples: sedans, coupes, motorcycles
   Average Fuel Efficiency: 23.9 mpg
   Light Duty Trucks: Class 3 & 5 Vehicles from FHWA
   Examples: trucks, vans, SUVs
   Average Fuel Efficiency: 17.3 mpg

[23] Please see vehicle class definition document for additional criteria and examples of vehicles for each class.

Heavy Duty Trucks: Class 4 & 6-13 Vehicles from FHWA
Examples: dump trucks, utility vehicles
Average Fuel Efficiency: 6.5 mpg

Sources: Vehicle Fleet **(DPW: Bill Berkel and Calvin Chambliss)**

2. The unit number in the 2016 Calendar Year Inventory was used to merge the data from All Active Units and Sold Units spreadsheet, so that only the calendar year data was represented in the spreadsheet. The Vlookup function was used to carry out this process.[24] Spreadsheet data included vehicle make, model, year, fuel use, fuel type, and mileage.
3. To calculate the total fuel usage, the spreadsheet was organized based on fuel type (gasoline-regular & premium unleaded, diesel, CNG)
4. The annual vehicle miles traveled for each fuel type was also calculated
5. The VMT percentage of passenger vehicles, light duty vehicles, and heavy duty vehicles in each category was calculated[25]
6. The annual emissions in metric tons of carbon dioxide equivalent was determine by entering annual usage for each sector into ClearPath

Data Collected

Fleet Inventory	Active On-Road Vehicles Active Off-Road Equipment Sold Units	DPW: Vehicle Fleet Calvin Chambliss Bill Berkel

Calculations/Data Manipulation

$$\% \text{ VMT} = \frac{VMT \text{ (1 vehicle class)}}{Total\ VMT \text{ (all vehicle classes)}}$$

Percentage VMT

Gasoline

	VMT	% VMT	Fuel Use
Passenger VMT	4,129,865	43.52%	283,926
Light Duty VMT	5,245,814	55.28%	536,999
Heavy Duty VMT	113,687	1.2%	12,280
Total	9,489,367		833,205

Diesel

	VMT	% VMT	Fuel Use
Passenger	0	0	0
Light Duty	301,831	22.04%	25,895
Heavy Duty	1,067,864	77.96%	294,625
Total	1,369,695		320,519

CNG

	VMT	% VMT	Fuel Use
Passenger VMT	27,095	20.09%	0
Light Duty VMT	90,802	67.32%	3,418
Heavy Duty VMT	16,990	12.60%	0
Total VMT	134,887		3,418

[24] Please note that all unit numbers should contain 6 digits. If there are less than 6 digits, 0s should be added to the beginning of the unit number until there are 6 digits. To learn how to use the vlookup function, please refer to the following link. https://www.youtube.com/watch?v=809m6kLTfgI

[25] Some of the vehicles in the fleet inventory contained negative mileage. This was due to inaccurate readings and additional human error. The negative mileage was not included in the inventory, however, the fuel use from these units were included.

Electric

	VMT	% VMT	Fuel Use
Passenger VMT	927	100%	0
Light Duty VMT	0	0%	0
Heavy Duty VMT	0	0%	0
Total VMT	135,815		3,418

ClearPath Input

Fuel Type	Annual Usage	Annual VMT
Gasoline	833,205 (2018)	Total= 10,924,781 % Heavy Duty = 1.2% % Light Duty = 55.28% % Passenger = 43.52%
Diesel	320,519 (2018)	Total = 1,369,695 % Heavy Duty = 77.96% % Light Duty = 22.04% % Passenger = 0%
CNG	3,418 (2018)	Total = 135,815 % Heavy Duty = 12.51% % Light Duty = 66.86 % % Passenger =20.63%
Electric	0 (2018)	Total = 927 % Heavy Duty = 0 % Light Duty = 0 % Passenger = 100%

Employee Commute

The methods and calculations presented in this document are based on Richmond's previous methodology for Employee Commute and data availability.

Key
Data Needed (highlighted)
Data Sources (bold)

Data Needed

- Activity Data
  - Vehicle Miles Traveled
  - Vehicle Type
  - Vehicle Model Year
- Indicator Data
  - Time and money spent on commute
  - Number of employees using alternative modes of transportation for commute
- Number of city employees (full-time and part-time)
- Number of sick days, vacation, holidays

Methodology
To determine the emissions from employee commutes, the following steps were taken:

Part 1: Capture employee commute data

1. The employee commute survey was created on survey monkey.com using the same questions as the 2013 survey. The survey contained a certain logic that allows the user to answer certain questions based on their previous responses.
2. The number of full-time and part-time City Of Richmond employees was obtained by the **Human Resource Department**.
   Source: Tonya Brinkley

3. The Employee Commute Survey response rate was determined by dividing the number of survey responses by the total number of employees
4. The average number of days off was determined: The number of sick and vacation days was obtained from the Human Resource Department. The total number of sick/vacation days was divided by the number of employees to determine the average number of sick/vacation days. The number of holidays was added to this value to determine the average number of days off
   Source: Catherine Cook

Part 2: Determine the Annual Vehicle Miles Traveled (AVMT) for employees that drive alone based on each fuel type (gasoline, diesel, electric, ethanol)

5. The Annual Vehicle Miles Traveled was calculated for each respondent
6. The estimated annual VMT for all employees driving alone was calculated using the sum of the values in STEP 5 and the response rate (STEP 3)
7. The percentage VMT for Passenger, Light Duty, and Heavy Trucks using each fuel type was determined

Part 3: Determine the Annual Vehicle Miles Traveled for employees that carpool based on each fuel type (gasoline, diesel, electric, ethanol)

8. The AVMT was calculated for each respondent, and this value was divided by the number of individuals in the carpool. Where there was no indication, it was assumed that two people were in the carpool.
9. The estimated AVMT for all employees carpooling was calculated using the sum of values in STEP 8 and the response rate
10. The percentage VMT for Passenger, Light Duty, and Heavy Trucks using each fuel type was determined.

Part 4: Enter Data into ClearPath

Data Collected

Step 1: Employee Commute Data	168 Responses	Survey Monkey
Step 2: Number of Employees	Full-Time: 4,120 Part-Time: 150 Total: 4,270	Human Resources Tonya Brinkley
Step 4: Number of Sick and Vacation Days	Sick/Vacation Days: 78,999 Average: 18.5 Holidays: 15 Total Days off: 33.5	Human Resources Catherine Cook

Data Manipulation/Calculations

Part 1: Determine Response Rate (Step 3)

$$Response\ Rate = \frac{Number\ of\ Responses}{Total\ Number\ of\ Employees}$$

$$Response\ Rate = \frac{168}{4{,}270}$$

$$Response\ Rate = 0.0393\ or\ 3.93\%$$

*To get a representative figure of all employees based on the response rate a multiplication factor of 25.41 will be applied. (3.93 x 25.42 = 99.88%)

Determine Average Number of Days Off

$$Average\ Sick\ \&\ Vacation\ Days = \frac{Total\ sick\ \&\ vacation\ days}{Number\ of\ Employees}$$

$$= \frac{78{,}999}{4{,}270}$$

$$= 26.5$$

$$Average\ Days\ Off = Average\ Sick\ \&\ Vacation\ Days + Holidays$$

$$= 18.5 + 15$$

$$= 33.5\ days$$

Part 2: Determine the Annual Vehicle Miles Traveled for all employees driving alone

Gasoline: Annual Vehicle Miles Traveled (Each respondent)

AVMT each respondent = (distance employee lives from work * 2) * ((number of days driven to work/wk * 52 wk/yr) – (average number of sick, holiday, and vacation days))

AVMT all respondents = sum of AVMT each respondent
=785,036.54 miles

Estimated AVMT for all employees driving alone (Gasoline)

Estimated AVMT for all employees driving alone =
$AVMT\ all\ respondents\ x\ multiplication\ factor\ based\ on\ response\ rate$
= 785,036.54 * 25.42
= 19,953,012 miles

Determine % VMT for each Vehicle Type

120 respondents commuted in vehicles that used gasoline (83 passenger; 37 light duty)

Representative # of employees 120 * 25.42 = 3,050

Passenger AVMT= 466,621.93 miles
Light Duty AVMT= 318,414.61 miles
Total AVMT = 785,036.54 miles

Representative # (AVMT) = 785,036.54*25.41 = 19,953,012

$$\%\ VMT = \frac{AVMT\ Vehicle\ Type}{Total\ AVMT}$$

Vehicle Type	*AVMT Miles*	*% AVMT*
Passenger	466,621.93	59%
Light Duty	318,414.61	41%
Total	785,036.54	

Electric (Drive alone):

AVMT all respondents = sum of AVMT each respondent
=9,059.96

Estimated AVMT for all employees driving alone =
$AVMT\ all\ respondents\ x\ multiplication\ factor\ based\ on\ response\ rate$
= 230,274.05

Vehicle Type	*AVMT Miles*	*% AVMT*
Passenger	9,059.96	100%
Light Duty		
Total	9,059.96	

One respondent commuted alone using an electric vehicle
Representative number of employees 1 * 25.41 = 25

Diesel (drive alone):

AVMT all respondents = sum of AVMT each respondent
=4,076.98

Estimated AVMT for all employees driving alone =
$AVMT\ all\ respondents\ x\ multiplication\ factor\ based\ on\ response\ rate$
= 103,623.32

Vehicle Type	*AVMT Miles*	*% AVMT*
Passenger	4,076.98	100%
Light Duty		
Total	4,076.98	

One respondent commuted alone using diesel
Representative number of employees 1 * 25.41 = 25

Part 3: Vehicle Miles Traveled (Carpool)

$$AVMT\ respondent\ carpool = \frac{Annual\ VMT\ each\ respondent\ (above\ equation)}{Number\ of\ people\ that\ carpooled}$$

*Due to a lack of data, it was assumed that two people participated in the carpool

$$= \frac{47{,}370.79}{2}$$

$$= 23{,}685.40$$

Estimated AVMT for all employees carpooling

Estimated AVMT for all employees carpooling =
$AVMT\ all\ respondents\ carpooling\ x\ multiplication\ factor\ based\ on\ response\ rate$
$= 23,685.40 * 25.42$

$$= 602,003.82\ miles$$

Determine % VMT for each Vehicle Type
Five respondents commuted in vehicles that used gasoline (5 passenger)

$$\%\ VMT = \frac{AVMT\ Vehicle\ Type}{Total\ AVMT}$$

Vehicle Type	*AVMT Miles*	*% AVMT*
Passenger	47,370.79	100
Light Duty		
Total	47,370.79	

ClearPath Input[26]

Drive Alone Gasoline

Fuel Type	Gasoline
Employee AVMT	19,953,012
% Passenger	59%
% Light Duty	41%
% Heavy Duty	0
Total Employees	3,404

Drive Alone Electric

Fuel Type	Gasoline
Employee AVMT	230,274.05
% Passenger	100%
% Light Duty	
% Heavy Duty	
Total Employees	25

Drive Alone Diesel

Fuel Type	Gasoline
Employee AVMT	103,623.32
% Passenger	100%
% Light Duty	
% Heavy Duty	
Total Employees	25

Carpool

Fuel Type	Gasoline
Employee AVMT	602,003.82
% Passenger	100%
% Light Duty	
% Heavy Duty	0
Total Employees	127

Solid Waste

The methods and calculations presented in this document are based on ICLEI's Local Government Protocol (9.3.1) and data availability.

Key
Data Needed (highlighted)
Data Sources (bold)

Data Needed

- Annual Waste Production/Waste Container Data
    - Locations serviced by private hauler

[26] Representative values were entered into ClearPath. The representative values are the AVMT * multiplication actor (25.41) and # of respondents * multiplication factor (25.41)

    - Number of containers at each location
    - Size of each container
    - Number of scheduled and on call pick-ups
- Waste Conversion Factors

Methodology
Calculating emissions from waste production involved the following steps:

1. Invoices from Container First Services were used to create a list of locations with number and size (volume) of containers, and pick-ups. These invoices were obtained from **Facilities Maintenance**
   Locations with compactors (Richmond City Jail and Richmond Police mounted stable) reported tons disposed. No additional manipulation was done to these sites[27]
   The number and size of containers and number of pick-ups for Parks & Rec waste was obtained from **Bryce Wilk**
2. The total volume in cubic yards for all containers at each location was determined
3. Based on the volume of the container, an estimation of the weight of waste produced was obtained
   Source: **EPA volume to mass conversion PDF**
4. The estimated mass of waste produced by each container was multiplied by the weekly number of scheduled or on call pick-ups for each container
5. To obtain an estimated monthly amount of waste produced, the estimated mass of weekly waste produced was multiplied by the number of weeks in a month (4)[28]
6. The average monthly waste production from DPW facilities was estimated by adding each invoice waste estimation total and dividing it by the number of invoices
7. An estimated annual waste production from DPW facilities was calculated by multiplying the average monthly waste production by 12.
8. An estimated annual waste production from Parks & Rec was calculated by multiplying the average weekly waste production value by 52 weeks
9. The annual emissions in metric tons of carbon dioxide equivalent was determined by entering annual waste produced into ClearPath

Data Collected

Number and size of container, pick up schedule	See Data Manipulation section	Facilities Maintenance Rossie Burnett Container First Services James River Park System Bryce Wilk
Volume to Mass Conversion Factor	MSW Commercial All Waste, Uncompacted Cubic yard = 138	EPA https://www.epa.gov/sites/production/files/2016-04/documents/volume_to_weight_conversion_factors_memorandum_04192016_508fnl.pdf
Lbs to Tons Conversion Factor	1 lb = 0.0005 tons	

Data Manipulation/Calculation
DPW Facilities
Estimated Maximum Weight = Total Cubic Yards x Conversion Factor (138 lbs)
Estimate the number of pick-ups within a month = # weekly pick-ups * 4

[27] Sites that show tons of waste can be identified by looking at the quantity value of the disposal. If the quantity is not equal to 1, then the value represents the tons of waste collected. At these sites, the haul values can be negated.
[28] This process was done for each invoice received from Container First Services.

Estimate the lbs picked up per month = estimated weight in container * number of pick-ups per month
Estimated tons = estimated lbs picked up * 0.0005
Total tons per month = sum of estimated tons at each location

Parks & Rec[29]
Annual # of pick-ups = weekly pick-ups * 52
Estimated waste produced = container size * 138 lbs
Estimated annual waste produced (lbs) = estimated waste produced * 52
Estimate annual tons = estimated annual waste produced * 0.0005
Total waste produced = estimated annual tons * number of containers

ClearPath Input

Total Waste Landfilled	1,946.664 tons

Process Emissions

The methods and calculations presented in this document are based on ICLEI's Local Government Protocol (6.1.1) and data availability.

Key
Data Needed (highlighted)
Data Sources (bold)

Data Needed

- Annual Refrigerant Usage
  - Fleet
  - Facilities

Methodology

Calculating Government GHG emissions from refrigerant usage involved the following steps:

1. Fleet refrigerant usage was obtained from the **Department of Public Works Fleet Maintenance**
2. Facilities refrigerant usage was obtained from the **Department of Public Works Facilities Maintenance**
   a. Note: Facilities Maintenance provided scanned logs of refrigerant tanks that were signed out of storage facilities
3. The annual emissions in metric tons of carbon dioxide equivalent was determined by entering annual usage for each sector into ClearPath

Data Collected (2015)

Fleet Refrigerant Usage	HFC-134A (R134A) = 657lbs	Department of Public Works Bill Berkel
Facilities Refrigerant Usage	R22 = 7 tanks 407-C = 3 tanks 410 –A = 18 tanks	Department of Public Works Samuel Pemberton

Calculations/Data Manipulation

Conversion Factor: 1lb = 0.00045359 metric tons

[29] Parks and Rec only had 2 size containers and the method to estimate annual waste production varied from DPW facilities. Please look at the Government Solid Waste Spreadsheet for details.

Facilities Refrigerant Usage

HCFC-22 (R22) = 7 TANKS x _30_LBS = _210__ LBS

$$210 lbs \left(\frac{0.00045359\ metric\ tons}{1lb}\right)$$

$$= 0.095254\ metric\ tons$$

HFC-407C = 3 TANKS x _25_LBS = _75__LBS

$$75\ lbs \left(\frac{0.00045359\ metric\ tons}{1lb}\right)$$

$$= 0.034019\ metric\ tons$$

HFC-410A 18 TANKS x _25_LBS = _450__LBS

$$450\ lbs \left(\frac{0.00045359\ metric\ tons}{1lb}\right)$$

$$= 0.204116\ metric\ tons$$

Total Lbs = 735 lbs = .333389 metric tons

Fleet Refrigerant Usage

HFC-134A (R134A) =657 lbs

$$675\ lbs \left(\frac{0.00045359\ metric\ tons}{1lb}\right)$$

$$= 0.298009\ metric\ tons$$

Clear Path Input

Facilities Refrigerant

Gas Type	Fugitive Gas Released
HCFC-22 (R22)	0.095254 metric tons
HFC-407C	0.034019 metric tons
HFC-410A	0.204116 metric tons

Fleet Refrigerant

Gas Type	Fugitive Gas Released
HCF-134	*0.298009*metric tons

Appendix D
GHG Modeling Deliverables

Appendix D: Greenhouse Gas Emissions Modeling Deliverables

Greenlink Analytics (Greenlink) was contracted in 2020-2021 to provide technical modeling for Richmond's greenhouse gas emissions future. Greenlink maintains critical baseline information on hundreds of US cities with the ability to view an hourly assessment for most energy and climate relevant needs. Their methodologies have been recognized as a key scientific contribution in academic journals, and have been used by dozens of cities to help better-calibrate baselines and they leverage public and proprietary data sets and models to create a comprehensive picture. The following assumptions and data sources were agreed on and used for the purpose of this project:

Buildings List
Buildings were assigned a Commercial Building Energy Consumption Survey (CBECS) Principle Building Activity (PBA) from 2018 tax assessor data aggregated into 10 building types.

Growth Rates
Projections of economic growth out 20-30 years from the VCU Center for Urban and Regional Analysis (CURA) were used to develop building growth (low/mid/high). (*Modification: Education = VCU + schools; VCU master plan for 20 years, extrapolated out and same for schools. Both groups assumed much greater growth than the CURA values, so adjustment was made to reflect that.)*

Energy Usage Intensity (EUI)
Greenlink ran calculations using 2015 Residential Energy Consumption Surveys (RECS) and 2012 CBECS data and assumed average performance then checked against actual data from Richmond's 2015 GHG Inventory. Finding was that the usage was too small (more incorrect for gas than for electric. EUIs were increased proportionally to the EUIs in CBECS; the relative EUIs were brought up to maintain the ratio between EUIs and building types (e.g. office vs hospitals as a 1:2 ratio would be maintained, even as the EUI was scaled to make sure the total consumption nets). (*Note: office building NG consumption is much higher in Richmond than other neighboring cities.)*

Industrial
Highly variable data so it has been smoothed historically to indicate the trend.

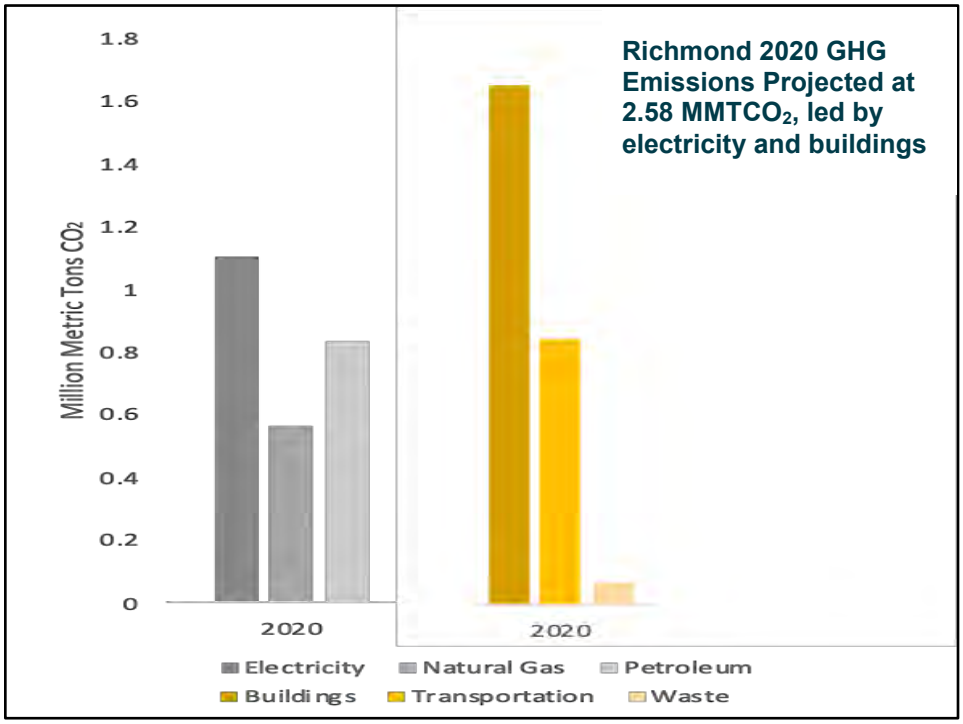
Transportation
Modeshare, Vehicle Miles Traveled (VMT) by class, etc. Turnover rate, applied Corporate Average Fuel Economy (CAFE) standards and adoption rates of EVs (BNEF). Mode shift was the only focus. Total trip demand (PMT) and growth projections were the big drivers, with modes adjusted. Land use changes were not addressed. Projected complete electrification for all purchases post 2028, which led to full EVs by 2043 (including bus fleet electrification). Bus investments increased as transit use increased in the model as well.

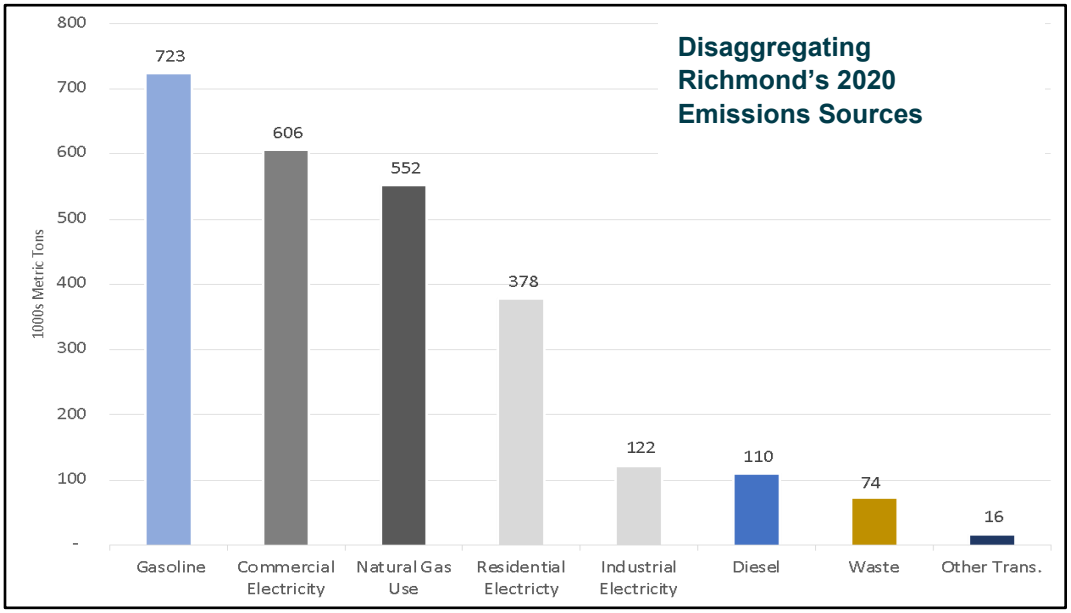
Modeling Methods

To understand where we are headed beyond a year likely requires sophisticated modeling efforts. To create credible forecasts, many technical, economic, social, cultural, and policy drivers need to be considered. To ensure that equity is centered in the modeling process it is

important to return to Richmond's public values and community priorities in designing the questions the model must answer. While "all models are wrong," a good model can improve our understanding of likely future outcomes especially when compared to other ways of describing the future.

Baseline data from City of Richmond, Google EIE, FERC, EIA, EPA, NREL, Dominion, VA SCC, USDOT, EV Manufacturers, Census was used to project emissions modeling for 2020.



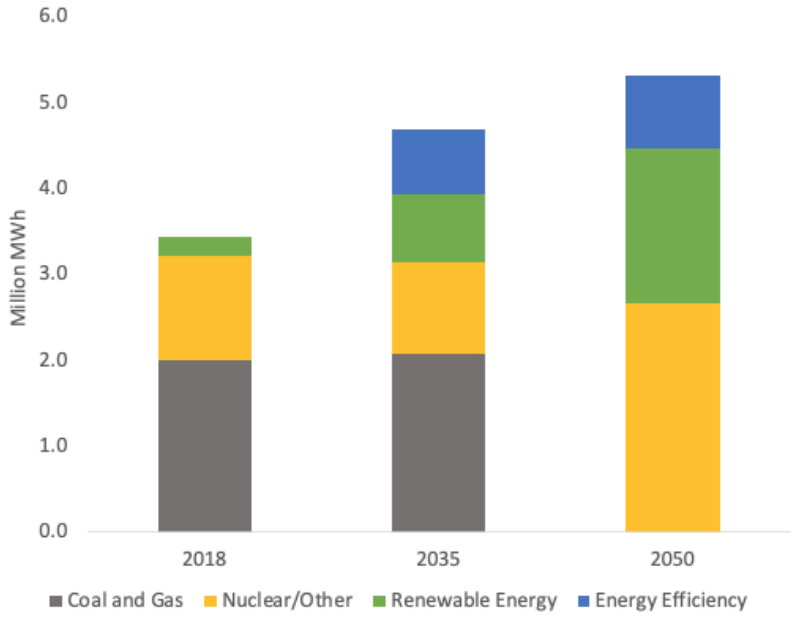


Future Projections Primarily driven by ATHENIA's machine-learning neural network architecture to derive hourly solutions to energy supply and demand in Richmond. (*Exception: waste projections use EPA WARM)*

Resource Impacts Achievable, cost-effective opportunities identified for buildings, transportation, and waste. Anything between the baseline and the last achievable resource addition is selectable in ACES.

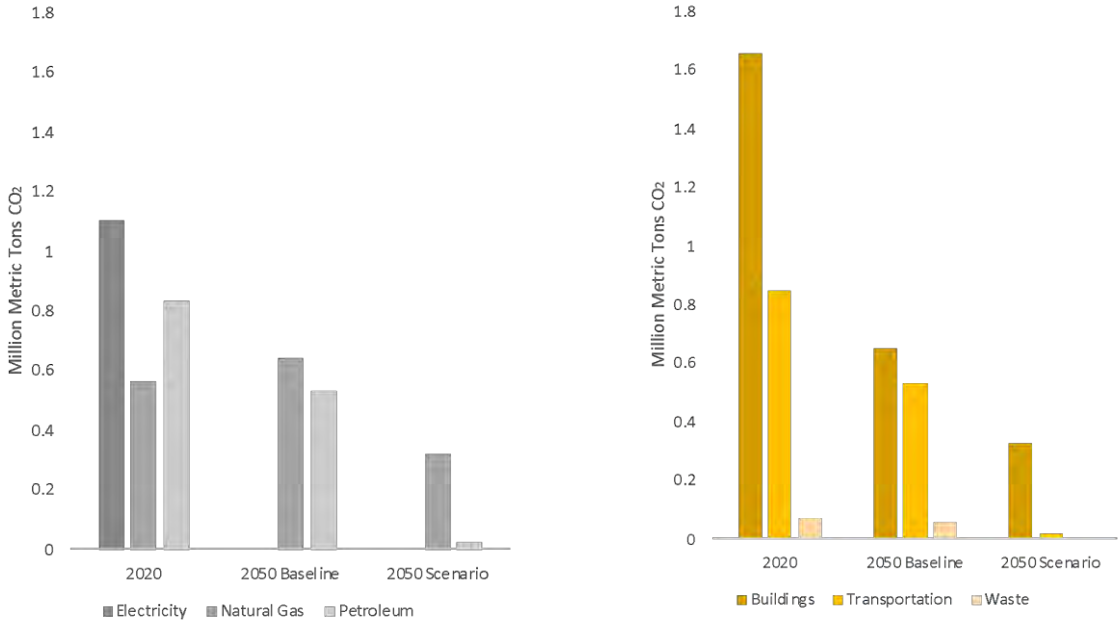
Primary Scenarios

Business-As-Usual (BAU): What happens if no new actions are initiated?



Based on this BAU modeling scenario, there will be significant increases in clean energy as a result of efforts made on behalf of our electric grid. However, in order to achieve net-zero GHG emissions from all sources additional policies and programs beyond what is existing today are needed.

Max Case: What happens if we aggressively pursue all of our achievable opportunities?



Decarbonization efforts could significantly cut GHG emissions by 2050 both by source and sector if aggressive policies and programs are implemented.

Energy Systems Analysis: ATHENIA

ATHENIA is Greenlink's proprietary, integrated modeling platform developed to support energy system analysis at multiple levels. Through the integration of hourly supply and demand-side dynamics of Dominion Energy's electric system with increased temporal and geographic resolution, the tool is able to monetize environmental and economic impacts of a changing energy mix. By moving to more realistic representation of future scenarios, ATHENIA better captures true system dynamics and can be used to make better planning and policy decisions.

Model	General Description	Resolution		Utility Variables					Customer Variables				Social Impacts					
		Temporal	Geographic	Supply-side Resources	Demand-Side Resources	Transmission & Distribution	Capital	Revenue	Demand	Load	Billing	Rates	Emissions	Emissions Compliance	GDP	Incomes	Jobs	Public Health
ATHENIA	**AI-enhanced energy policy model**	**hourly**	**local/EGU and up**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**

How ATHENIA is Organized?

In order to develop high resolution demand profiles the following inputs were used (note- all hourly demands were aggregated back to sectoral demand signal):

Building Stock and EV Characterization

- 21 building types with multiple age cohorts for over 100 typical building representations
- EV forecast and charging characteristics incorporated

Load Profile Development

- End-use level controls and integrated hourly building modeling
- Power factor and demand profiles established for industrial uses

Weights and Aggregation

- Weights assigned to each typical building representation by square foot and demand, derived from Google EIE, EIA and Census surveys, and other inventories

ATHENIA is unique in that it incorporates real-world supply and demand. It calculates non-grid fuels that are delivered to meet demand directly and adjusts for remaining hourly energy demand to be met by the power and gas grid supply. Also, ATHENIA dispatches supply side resources to match the remaining demand. These methodologies have led to an 800x improvement in accuracy over the industry-standard EIA model in forecasting power plant behaviors.

Tying "Where We Are Now" to "Where Are We Going": *ACES*

ACES is an interactive model used to forecast Richmond's future outcomes by aligning a variety of vision and action categories from user-defined scenarios and addressing emissions in the buildings, transportation, and waste sectors by leveraging the insights of Greenlink's machine learning energy model ATHENIA. ACES is helpful in understanding and evaluating the baseline and when set to its Business as Usual (BAU) calibration, it will inform people about projected future states of the community from the baseline values. ACES is most useful in exploring which strategies will lead to recognizing and realizing public values and provides details on costs, benefits, job creation, public health, bills, and energy burden for user-defined effort levels in 20 different areas of decarbonization:

- Residential Electric Efficiency
- Commercial Electric Efficiency
- Industrial Electric Efficiency
- Residential Gas Efficiency
- Commercial Gas Efficiency
- Industrial Gas Efficiency
- Residential Rooftop Solar
- Commercial/Industrial Solar
- Community Solar
- Residential Battery Storage
- Commercial/Industrial Battery Storage
- Carbon Offsets/Renewable Energy Credits
- Increased Transit through Land-Use and Commuter Incentives
- Electric Vehicle Adoption
- Alternative Commute Modes
- Electrified Transit
- Expanded Recycling
- Curbside Organics Collection and Composting
- Unit-based Pricing for Refuse Collection
- Biogas Capture and Use from Landfills and Wastewater

YOUR 2050 PATHWAY REPORT CARD

What Your Vision Would Mean for Richmond

COST OVERVIEW

Cumulative Benefits (Billion-$)	6.643
Cumulative Costs (Billion-$)	3.053
Net Benefits (Billion-$)	3.6
Benefit/Cost Ratio	2.2

2050 RICHMOND CLEAN ENERGY SUMMARY

Richmond's Electricity Offset by Building Energy Efficiency	62%
Richmond's Renewable Electricity Supply	80%
Utility Scale Solar Dedicated Capacity (MW)	374
Residential Solar Capacity Installed (MW)	22.8
Commercial Solar Capacity Installed (MW)	74
Reduction in Gasoline Consumption from 2018	100%
Electric Vehicle as a % of Light-duty Vehicles	99%

ENERGY EQUITY

Now and in 2050

COMMUNITY-WIDE ENERGY BURDEN	% of Income Spent on Energy Bills
Today	2.8%
2050, No Change	3.5%
2050, Selected Scenario	3.0%

IMPACT OF YOUR PATHWAY ON RICHMOND'S FUTURE

Through 2050

ECONOMY	FULL IMPACT	EQUAL TO	
Jobs Created	10,925	1.1	x Capital One Workforce
Incomes Increased	$1,668,000,000	$226	per Richmond resident per year

Through 2050

PUBLIC HEALTH	FULL IMPACT	EQUAL TO	
Public Health Savings	$231,000,000	$3	Monthly Health Insurance Savings
CO_2 Emissions Avoided (Metric Tons)	6,016,711	25	Months without Cars

In 2050

EXPENDITURE SAVINGS	FULL IMPACT	EQUAL TO	
Household Energy Bill Savings	$81,000,000		
Annual Bill Savings: Participants	$1,103	$92	Savings on monthly electricity bills
Annual Bill Savings: Non Participants	$105	$9	Savings on monthly electricity bills
Gasoline Savings	$574,000,000	$121	Savings per Richmond driver per year

To assist with strategy prioritization, ACES helped inform and clarify which strategies can best help to put the public values into practice.

ELECTRICITY AND POWER PRODUCTION

Energy Measure Input No. 1

ENERGY EFFICIENCY (Electric)

	ACTION		IMPACT	
Residential Potential Achieved	100%	*Residential Potential Achieved*	39,600	*# of homes cutting electricity by half*
Commercial Potential Achieved	100%	*Commercial Potential Achieved*	7.0	*kWh-saved per sqft.*
Industrial Potential Achieved	100%	*Industrial Potential Achieved*	1.9	*kWh-saved per sqft.*

Energy Measure Input No. 2

ENERGY EFFICIENCY (Natural Gas)

	ACTION		IMPACT	
Residential Potential Achieved	100%	*% of Additional Generation Potential Achieved*	52%	*% saved*
Commercial Potential Achieved	100%	*% of Additional Generation Potential Achieved*	55%	*% saved*
Industrial Potential Achieved	100%	*% of Additional Generation Potential Achieved*	18%	*% saved*

Energy Measure Input No. 3

SOLAR POWER

	ACTION		IMPACT	
Residential Solar Power	100%	*Residential Solar Potential Achieved*	4,300	*Homes adding solar*
Commercial Solar Power	100%	*Commercial Solar Potential Achieved*	3,100	*Buildings adding solar*
Community Solar	100%	*Community Solar Potential Achieved*	7,200	*Number of homes powered*

Energy Measure Input No. 5

ENERGY STORAGE

	ACTION	IMPACT	
Residential Battery Storage	100%	4,100	*Homes with battery back-up*
Commercial Battery Storage	100%	2,700	*Buildings adding batteries*

Renewable Energy Credits

Virginia-based	100%	National	0%

TRANSPORTATION

Energy Measure Input No. 5

Encourage Transit Through Land-use and Commute Incentives

	ACTION		IMPACT	
Reduction in Private Vehicle Miles Traveled	100%	*Maximum-achievable reduction (%)*	21%	*Reduction in Vehicle Miles Traveled in 2030*

Energy Measure Input No. 6

Electric Vehicles Adoption

			IMPACT	
Electric Vehicles Adoption	20%	7% is business-as-usual *Annual growth rate (%)*	99%	*EVs as a % of Richmond Light-duty Vehicles*

Energy Measure Input No. 7

Alternative Commute Modes

	ACTION		IMPACT	
Commute Via Bicycles	33%	2% is business-as-usual *Cyclists as a % of commuters in 2050. Input value between 0.25% to 33%*	238	*Million Miles of Single-Occupant Vehicle Travel Avoided*

Energy Measure Input No. 8

Clean Public Transit

	ACTION		IMPACT	
Electric/Hybrid Electric Buses	100%	0% is business-as-usual *Electric/Hybrid Electric Buses as a % of Total Bus Fleet in Richmond in*	13,700,000	*Miles Traveled by Electric/Hybrid Buses in 2050*

WASTE

Waste Measure Input No. 1

Expanded Recycling

	ACTION	START YEAR	IMPACT	
Increased Curbside Recycling, including Commercial and Multifamily Housing	100%	2023	11.6	*x more tons recycled than 2020 by 2050*

Waste Measure Input No. 2

Organics Collection

	ACTION	START YEAR	IMPACT	
Curbside Organics Collection and Composting	100%	2023	20%	*Reduction in 2050 landfill waste*

Waste Measure Input No. 3

Source Reduction

	ACTION	START YEAR	IMPACT	
Unit-Based Pricing for Refuse Collection	100%	2030	63%	*Reduction in residential waste*

**Requires Expanded Recycling at 100%*

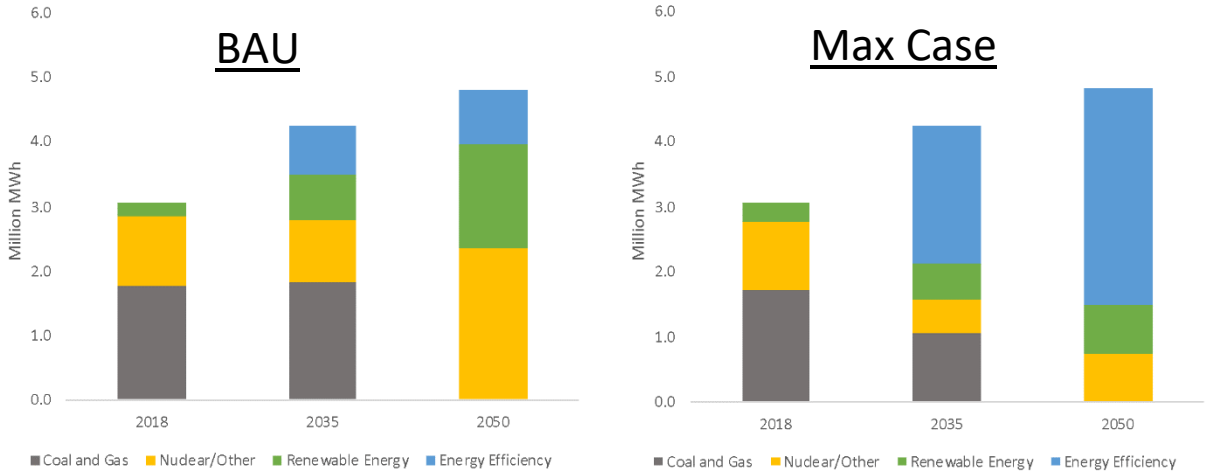
Waste Measure Input No. 4

Biogas Capture and Use

	ACTION	START YEAR	IMPACT	
Develop new landfill and wastewater treatment gas capture	Yes	2030	2,000	*Homes-worth of gas demand offset*

Efficiency

ATHENIA calculates the impact on hourly building energy demand that would be modified by investments in efficiency. Maximum savings for both electric and gas were limited by achievable cost-effective potentials. Costs were determined on the amount of efficiency already achieved (i.e. the more efficiency achieved in the past, the more expensive the new savings become). The identification of cost-effective technology options are model outputs assessing over 600 technologies and thousands of different building/manufacturing configurations. The final modeling as performed by Greenlink builds on work by NREL (residential), ACEEE (residential/commercial/industrial), EIA (residential/commercial/industrial), and ORNL (industrial).



Delivered Electricity: 46% Virginia renewables, 54% nuclear & imported renewables. Efficiency reduces demand by 63% in the 'Max Case' scenario.

Solar

Utility-scale and distributed resources were modeled for Richmond's potential future. Utility-scale additions follow Dominion plans to comply with the Virginia Clean Economy Act and distributed generation additions are forecasted from an ATHENIA submodule that is informed by 7 years of historical Richmond rooftop solar data. The submodule:

- Learns customer behavior;
- Accounts for improvements in manufacturing processes and installer learning; and
- Assesses the impact that better permitting, bulk purchasing programs, direct subsidy, and clustered projects would have

Storage

Utility-scale and distributed resources were modeled for Richmond's potential future regarding energy storage with the same approach as solar, with some minor differences due to its shorter track record.

- All systems modeled are 4-hr duration Li+ batteries (capacity levels vary based on application)r;
- Utility-scale additions follow Dominion plans to comply with the Virginia Clean Economy Act;
- Customer price elasticities from solar are used for storage due to limited information; regional data is used to estimate Richmond baselines due to a weaker data reporting infrastructure for storage than solar;
- Technology learning curves are incorporated; Lazard and NREL data are used to supplement and improve price forecasts

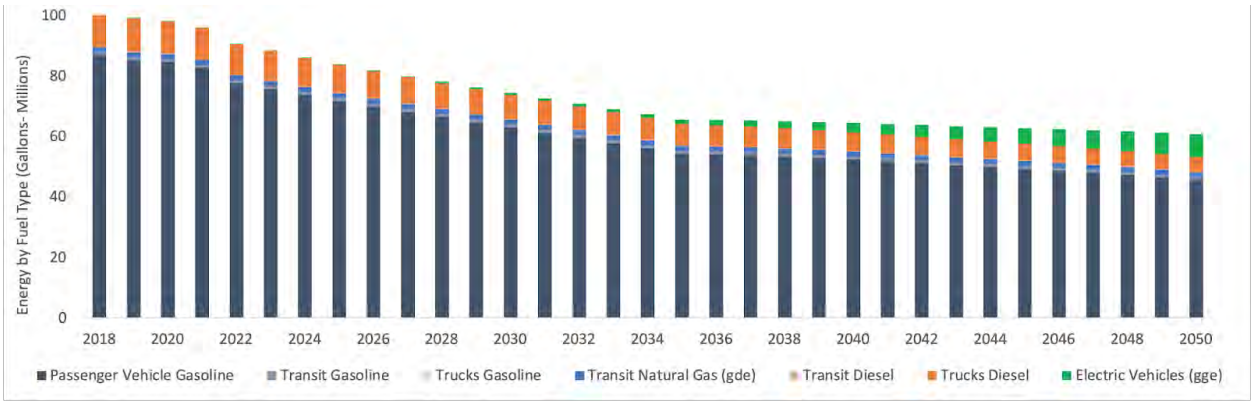
Light-Duty Electric Vehicles

The BAU of electric vehicle ownership is aligned with Richmond registration data and projected to grow at the same rate as the official Virginia EV forecast, where EVs are half of all new light-duty vehicles (LDV) sales by 2050. Users can accelerate this adoption rate such that nearly all LDVs are EVs by 2050. The amount of EV adoption changes gasoline and diesel fuel consumption based on the average fleet efficiency in a given year (note- this may be conservative if consumers predominantly replace older, less efficient vehicles with EVs). EV charging patterns and splits between residential and commercial charging are taken from OEM reports on user behaviors.

Transit and Bike/Pedestrian Modes

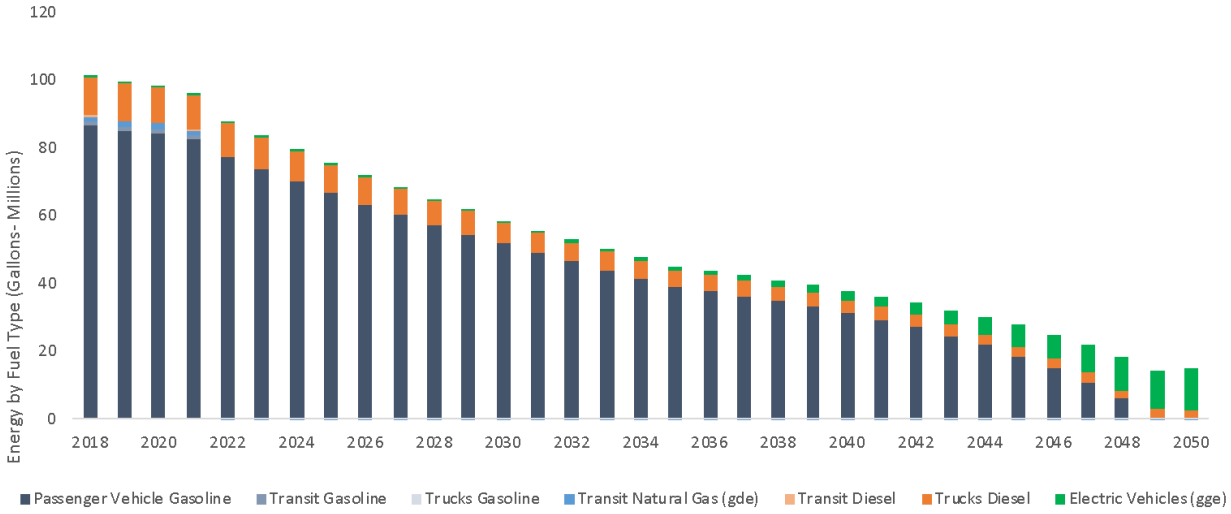
ACES transportation outputs are modeled by transportation mode and fuel type in order to measure the energy use by fuel type and transportation-related public health benefits. Incentivizing a higher utilization of cleaner transit and shifting to bike/ped modes is the most effective model to get us toward net zero in the transportation sector. To model this scenario, land use, zoning, commuter incentives, behavioral "nudging" through traffic notifications and increased frequency of the transit system are leveraged. The impacts of these efforts are derived from a literature review of over 100 studies.[1] Higher use of transit reduces private vehicle miles traveled and changes in energy consumption are assessed and users can choose to model transit electrification up to 100% in order to see the impacts. Similar treatment of the impact on fuels is incorporated. Alternative commute modes expands the bike/pedestrian infrastructure and adds more pathways for additional travel modes (such as electric scooters) to aid in personal transport.

BAU



[1] Greenlink Analytics and the Stockholm Environment Institute. 2021. American Cities Climate Challenge Impact Analysis Model Bibliography. Available at: https://static1.squarespace.com/static/5b10496285ede123439a633d/t/60dc6fdb3eb13c30c6a6a955/1625059291831/ACCC+IAM+Bibliography+.pdf

Max Case



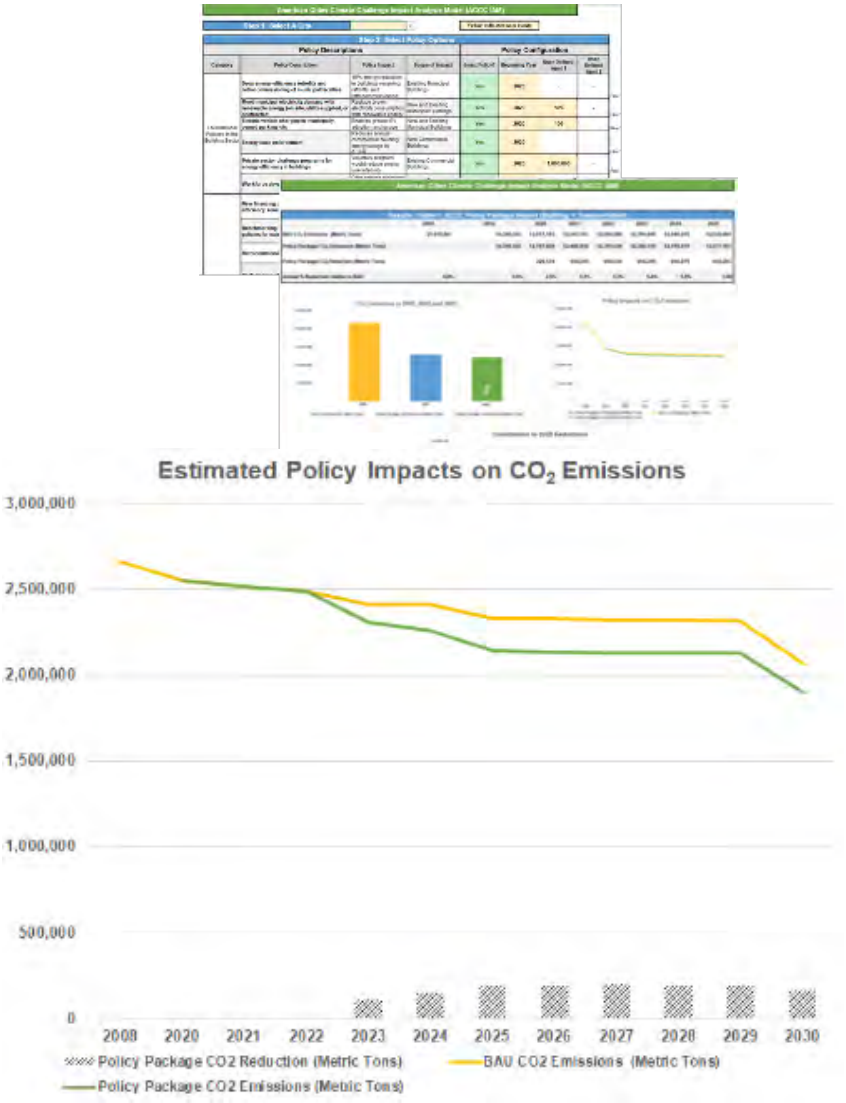
Waste Modeling

The EPA's industry-standard Waste Reduction Model (WARM) is a Life Cycle Analysis (LCA) tool that calculates savings across the full lifecycle of a product, regardless of location, and not necessarily in the same year. This differs from standard inventory approaches, which look at emissions attributable to a city in a given year. This is important when analyzing the emissions from the waste stream due to the long-term breakdown of materials that generate emissions. WARM was used to calculate specific GHG intensities for each component of the waste stream along with energy savings and economic impacts (i.e. labor hours, wages, and taxes) of the baseline and the results of implementing alternative waste management practices including source reduction, recycling, combustion, composting, anaerobic digestion and landfilling. Life Cycle Analyses should not be confused with forecasting tools. WARM uses LCA data to calculate the total GHG emissions associated with the waste stream for a point in time. A custom standalone waste model was built using WARM inputs and reductions were then applied from specific policies leading to shifts in different waste streams in order to calculate the impacts over the lifecycle. The reduced tonnage of the specific types of waste shifted the GHG intensity for the residual refuse and estimated GHG savings were then discounted when imported into ACES to better align with the total GHG inventory boundary. The waste model analyzes the effects of 0-100% effort levels of recycling, organics collection, save-as-you-throw programming, and biogas capture and reuse. Other outputs were taken and used to assess public health and economic development implications of these efforts. Outputs assessed in ACES are:

- Solid waste business-as-usual trajectory
- Solid waste scenario trajectory
- Solid waste GHG lifecycle emissions totals
- Wastewater emissions business-as-usual trajectory
- Waste emissions trajectory with LFG and biogas utilization including lifecycle emissions impacts.

How Far Will Specific Policy Options Bring Us: *IAM*

Greenlink's Impact Analysis Model (IAM) provides ballpark estimates of the impacts of roughly 40 policy options that push clean energy forward in the buildings and transportation sectors. The IAM also accounts for policy interactions, an important but frequently overlooked issue, that can cause missed opportunities for policy synergies or double counting the impact of combinations of policy options. The IAM can be used to help add detail and context to the Clean Energy Policy Toolkit and distinguish between options that might appear similar in the qualitative rankings. It also allows the user to explore the scale of impact for individual types of strategies implemented at various levels. In addition, the interaction between multiple types of strategies can also be evaluated.



Decarbonization Investments: What will it cost?

Utility investments are driven by state processes and viewed as outside of Richmond's direct ability to change. However, in order to model the costs of all strategies several assumptions were made:

- Efficiency investments are placed into 5 blocks in ascending order of costs by sector and as more efficiency is achieved it becomes more expensive.
- Costs are derived from a distribution of cost-of-saved energy estimates that Greenlink derives from utility programs and the clean energy potentials analysis.
- The total installed cost of solar and storage varies by sector and is an output of the earlier-described solar methodology.
- Cost varies by the quantity of solar or storage installed.
- Renewable Energy Credits and Carbon Offsets are assumed to cost $10.
- Average marginal costs of electric vehicles are incorporated for private vehicles and transit, which decline over time.
- Program and administrative costs across all sectors are included in the algorithm.

Decarbonization Savings

What kind of return will we see for our investment?

- Energy savings (electric, natural gas, transportation fuels) are captured by multiplying the fuel savings by the cost of the fuel in the particular year. If Richmond's efforts would change the price of the fuel, that is included (described on the upcoming utility financials slide)
- Public health benefits from reduced emissions are monetized (described on the upcoming public health slide)
- Broader benefits of reducing CO2 emissions are monetized using the 2016 Social Cost of Carbon from the US Interagency Working Group

Utility Financials and Bill Impacts

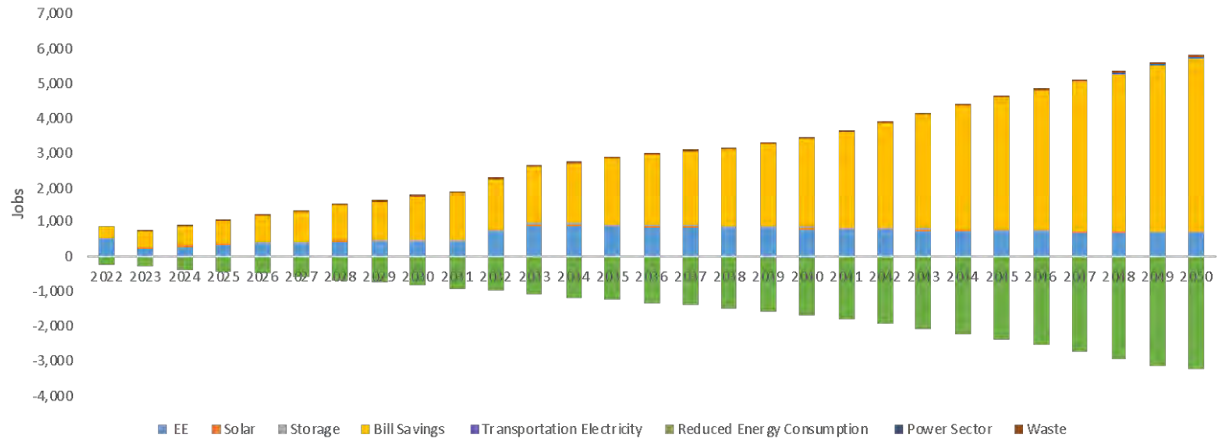
Changes in demand are managed by the Utility Financials Module, a peer-reviewed model that Greenlink co-developed with Georgia Tech that assesses how changes in investments and sales impact utility profitability, rates, and customer bills. Primary outputs are the change in rates used to calculate resulting energy costs in Richmond:

- Impacts on rates and bills for residential and commercial/industrial customers of Dominion are calculated, under both BAU and scenario conditions
- Any changes in sales and rates ultimately get reflected as bill impacts
- To provide an equity focus, impacts for average "clean energy" participants and non-participants are shown so the impact on those who access programs can be assessed next to those who do not

Economic Development Indicators

In order to assess the impact that each scenario will have on income and jobs, Greenlink constructed a macroeconomic model of Richmond using IMPLAN software. Outputs of this analysis are incorporated into the Economic Development submodule of ACES, where investments into specific decarbonization approaches can be assessed for their direct, indirect, and induced effects.

Max Case Job Impacts Sees 1000s of New Jobs



NET JOB-YEARS THROUGH 2050	
Sector	**Net Job-Years**
Construction	6,643
Lighting	1,917
Material for Envelope	1,494
Other Electrical Equipment	929
Energy and Environmental Management and Smart Controls	4,154
Insurance and Finance	440
Program Administration	1,882
Architecture and Engineering Services	1,438
Waste	810
General Economy	65,494
Fuel and Utilities	(42,717)
JOB-YEARS GAINED	85,200
JOB-YEARS LOST	(42,717)
TOTAL NET JOB-YEARS	**42,483**
TOTAL NET JOBS	**10,925**

Notes:

- The economic development implications of investments were assessed among 550 sectors
- The net effect (new investments in one area will create some gains and losses) on jobs and incomes is reported back on the Report Card
- The scenario net job creation is shown by cause of change in jobs in areas of energy efficiency and through bills savings.
- Net job-years are depicted for 11 sectors that see significant variation through 2050.

Energy Equity

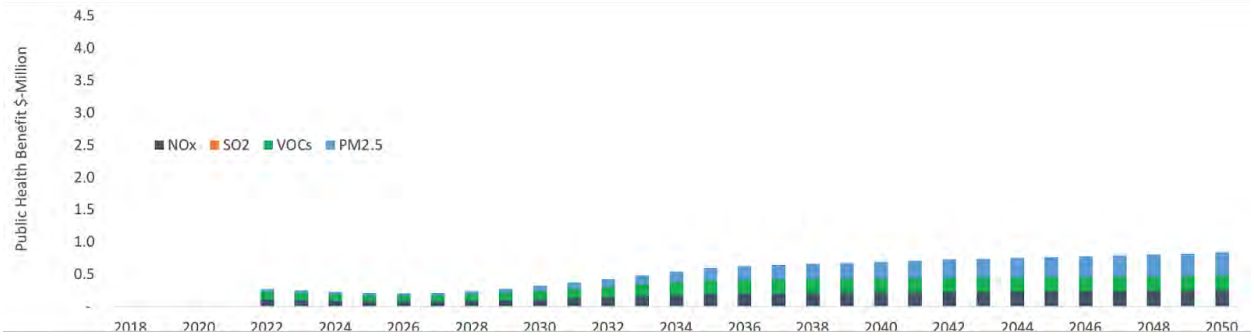
ACES contains a baseline forecast of income growth and the BAU outcomes of average residential energy bills. The scenario choices from a user may impact average incomes in Richmond (an output of the Economic Development analysis) and average energy bills (an output of the Utility Financial analysis). Dividing these values produces a new average energy burden for Richmond in a future year.

Public Health Impacts

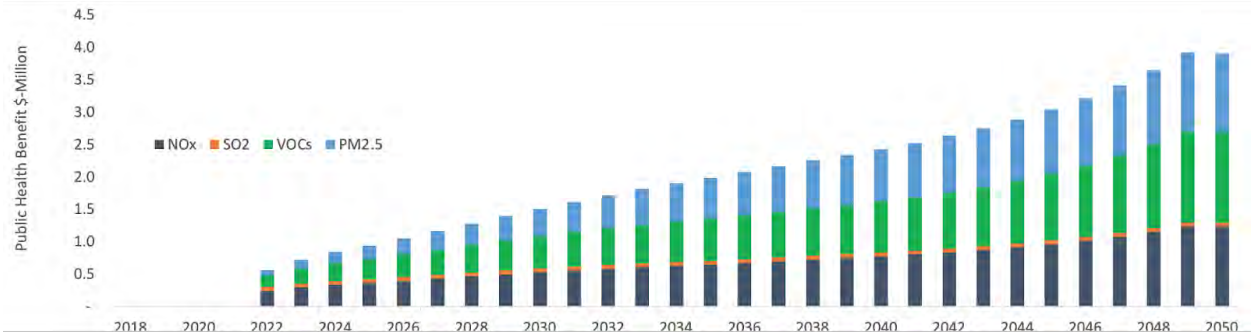
Emissions and public health impacts draw from ATHENIA's locational and public health damages data, showing damage per energy by hour.

- Changes in energy consumption patterns cause changes in emissions
- Changes in emissions cause changes in public health outcomes
- Public health benefits are monetized by coupling ATHENIA outputs with the AP2 Gaussian-plume reduced form air quality damages model. This evaluates power sector and transportation emissions benefits in the form of reduced healthcare costs from things like asthma, ER visits, heart attacks, etc
- In ACES, this is evaluated as damage per energy consumed; as energy consumption changes, damages decline

BAU



Max Case



Community health benefits resulting from the implementation of successful transportation strategies will lead to a 500% greater improvement by 2050 in the 'Max Case' scenario.

Cost-Effectiveness

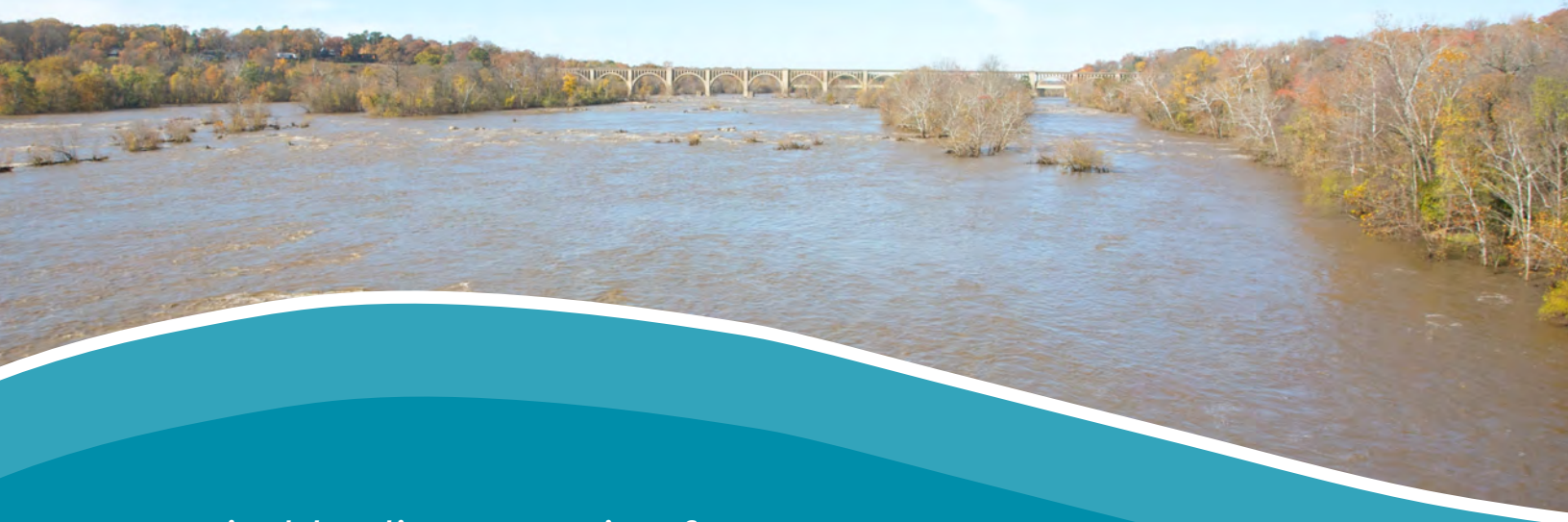
Calculating for cost-effectiveness of various scenarios requires the collection of all changes in investment streams, savings, and emissions externalities. Once all costs and benefits are monetized and calculated for all sectors, they are tabulated annually. Results are discounted at 3% to produce a present value of the scenario's benefits and costs. Subtracting discounted benefits from discounted costs represents the net present value of the scenario. Dividing instead of subtracting produces the benefit/cost ratio of the scenario.

Appendix E
Climate Vulnerability and Risk Assessment

FINAL | JUNE 2022

City of Richmond
RVAgreen 2050

Climate Vulnerability and Risk Assessment



Equitable climate action for a healthy and resilient Richmond

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Urban Sustainability Directors Network (USDN)

VCU Students and Faculty- Prof. Meghan Gough- Sustainable Community Development -Spring 2021

VCU Students and Faculty- Prof. Barry O'Keefe-Visualizing Ecological Crisis-Fall 2021

Virginia Community Voice

Virginia Department of Game and Inland Fisheries

Virginia Tech - Conservation Management

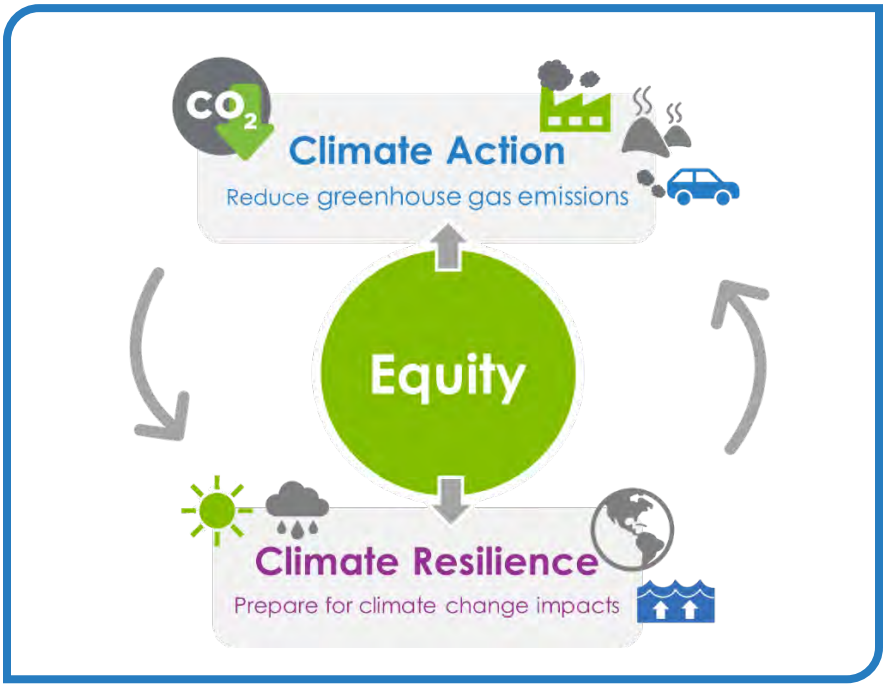
Table of Contents

1. Introduction

RVAgreen 2050 is the City of Richmond's equity-centered climate action and resilience planning initiative, spearheaded by the Office of Sustainability, to reduce greenhouse gas emissions 45% by 2030, achieve net zero greenhouse gas emissions by 2050 and help the community adapt to Richmond's climate impacts of extreme heat, severe storms, and flooding.

This Climate Vulnerability and Risk Assessment was created as an iterative process and is critical to understanding the specific climate threats Richmond is currently facing and will face in the coming decades, as well as the vulnerabilities of Richmond's social, built, and natural resources to increasing climate risks. This report summarizes the threats, vulnerabilities, and risks, and attempts to identify priority areas for most immediate action. Key recommendations will be integrated into implementation of the RVAgreen 2050: Climate Equity Action Plan 2030.

The report details the methodology used to measure vulnerability to and risk from to these climate impacts within the City of Richmond and reports the results of the analysis.



WHAT ARE GREENHOUSE GASES?

Greenhouse gases (GHGs) are gases in the earth's atmosphere that trap heat and warm the planet. GHGs include carbon dioxide, methane, nitrous oxide, and fluorinated gases. The right proportion of GHGs keep our planet warm enough to support life. When there are too many GHGs in our atmosphere, too much heat is trapped and overall temperature rises.

Human activity such as burning fossil fuels has caused a dramatic increase in these gases since around 1900, and the trend has rapidly accelerated in recent years.

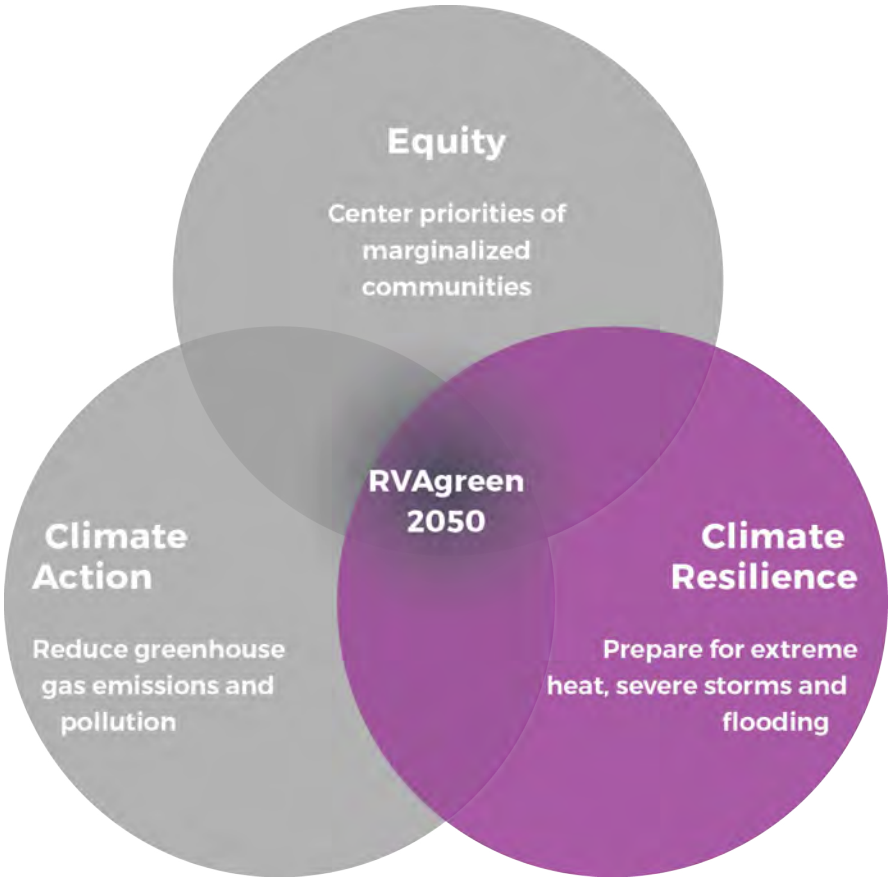
REPORT PURPOSE

1. Document the data-driven and science-based collaboration with the Richmond community in the RVAgreen 2050 climate vulnerability and risk assessment process.

2. Document the process by which indicators of social and physical vulnerability and risk were selected, how the data on these indicators was acquired, and how that data was used to create the maps used in the assessment.

3. Analyze, summarize, and prioritize climate change vulnerabilities and risks to Richmond communities and natural and physical assets.

4. Integrate climate risks and vulnerabilities into the RVAgreen 2050 initiative and implementation of the Climate Equity Action Plan 2030. Provide information on the methodology employed for use in future updates by the City of Richmond or peer cities using this as a guide for their own assessments.



Climate Emergency Resolution

Richmond City Council unanimously adopted Resolution No. 2021- R049 in September 2021 to "declare the existence of a climate and ecological emergency that threatens the City of Richmond, the surrounding region, the Commonwealth of Virginia, civilization, humanity, and the natural world." City Council also acknowledged during this process the inequitable impacts on communities at the frontline of climate change and called for climate resilience measures that would dismantle the systemic structures that undermine the health of minority communities.

2. Assessment Process

The City of Richmond completed a comprehensive process for identifying climate impacts, vulnerabilities, and risks to the community's built, social, and environmental assets, as well as for prioritizing actions for those assets with the highest vulnerability and facing the highest risk.

The assessment process (process graphic shown on page 6) includes five main components:

1. a description of the latest scientific information available on climate impacts to Richmond
2. an evaluation of the vulnerabilities present
3. an assessment of the risks that climate impacts create for Richmond's population and built and natural assets
4. an analysis of the populations and built and natural assets at highest risk from climate impacts
5. a determination of planning areas that can inform prioritization and recommendations for climate resilience actions

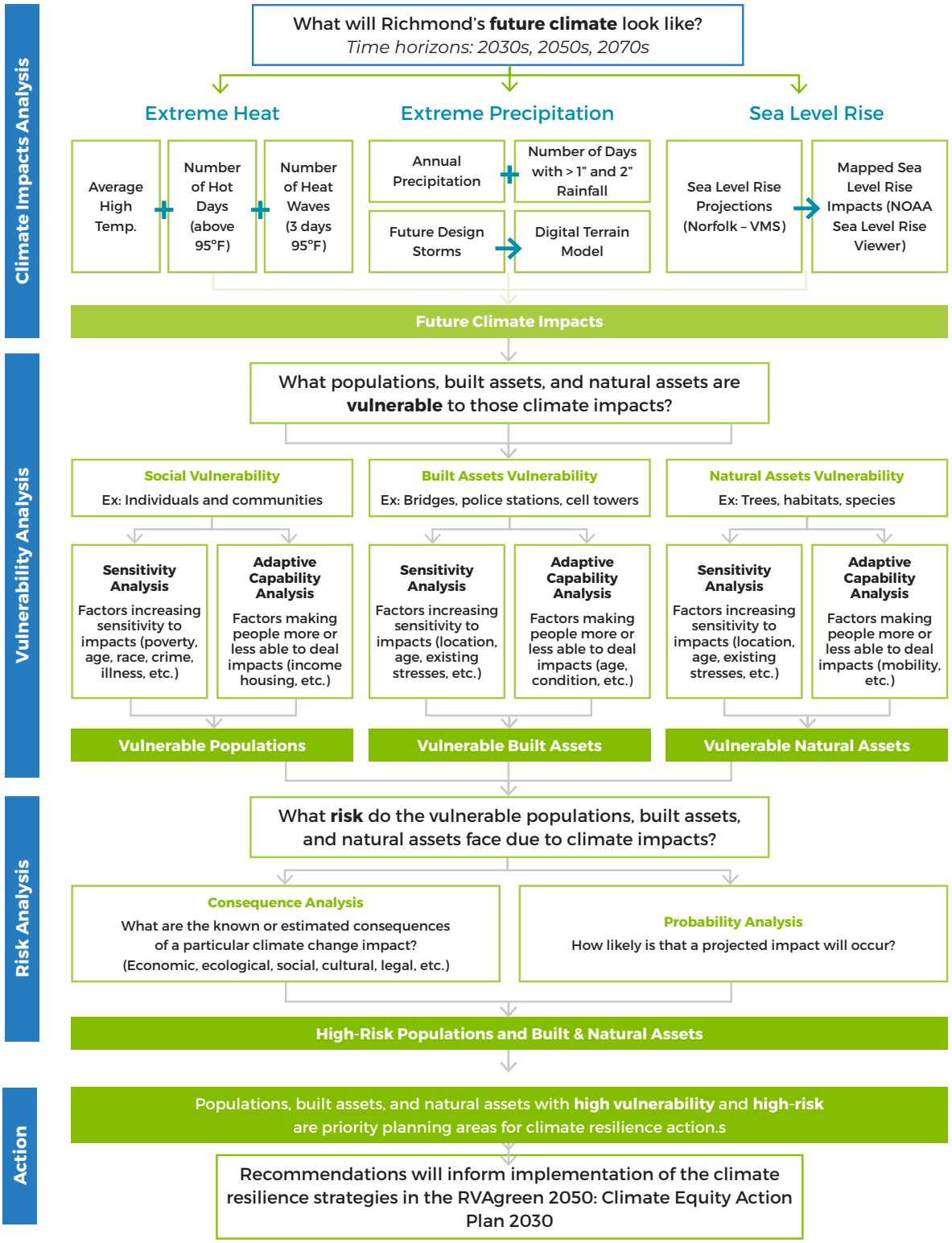
The Climate Vulnerability and Risk Assessment methodology is based on best practice guidance from organizations such as the Urban Sustainability Directors Network, ICLEI – Local Governments for Sustainability, and the National Association of Climate Resilience Planners

In addition, similar assessments and advice from peer cities were immensely valuable in this process. These include: Asheville, NC; Boston, MA; Cambridge, MA; Cleveland, OH; Minneapolis, MN; Portland, OR; Sarasota, FL; Somerville, MA; and, Washington, DC.

Finally, numerous local, state, and national experts assisted with identifying and gathering data, advising on best practices and the latest scientific information, and translating complex concepts for practical use by practitioners and the community. These include representatives from the City of Richmond, Conservation Management Institute at Virginia Tech, James River Association, Mid-Atlantic Regional Integrated Sciences and Assessments, Science Museum of Virginia, and Virginia Department of Game and Inland Fisheries, among other organizations.

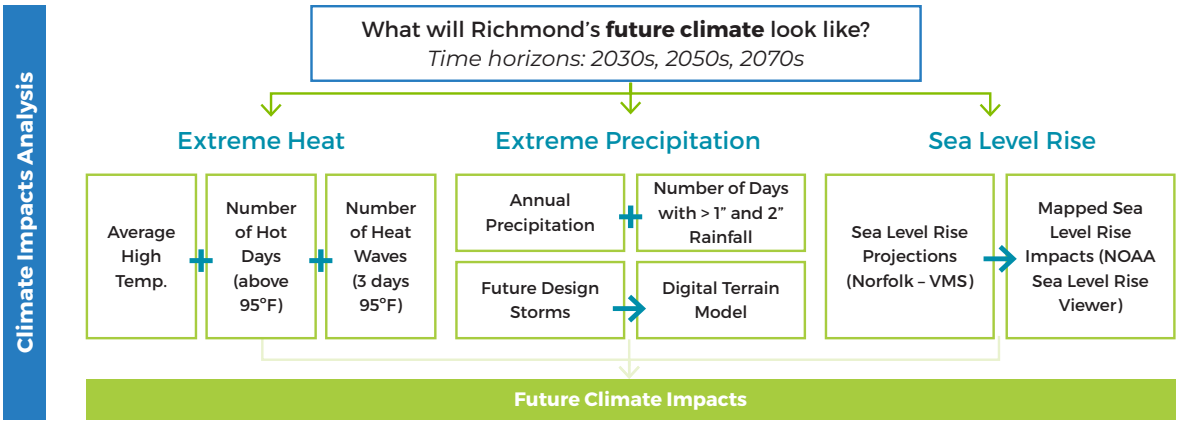
Climate Vulnerability and Risk Assessment Process

What action is needed for Richmond to prepare for or adapt to climate change?



3. Climate Impacts

Climate is defined as the long-term weather pattern in a region, and it is increasingly changing throughout the world. Research and the associated data show that global land-surface temperature, sea-surface temperature, and sea level have dramatically increased while snow cover and sea ice extent have decreased over the past 100 years.



The currently changing climate is linked to rising concentrations of greenhouse gases such as carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons in the atmosphere, which insulate the planet and cause it to warm. Greenhouse gases have been released through both natural processes and human activities such as livestock raising, changing land uses and landcover, and burning fossil fuels, especially for energy and transportation.

Due to decades of burning fossil fuels and other activities, dangerous amounts of greenhouse gases are now in the atmosphere and are disrupting Earth's climate.

The impacts of climate change vary by location. Some areas of the country experience more droughts and forest fires. Richmond is already experiencing hotter average temperatures, more heat waves, and more severe storms. These impacts are projected to increase in the future. The City completed a number of steps to identify the climate risks Richmond is facing now and is expected to experience in the coming decades. Data for the region, state, and Richmond was collected from the U.S. Climate Resilience Toolkit - Climate Explorer, National Oceanic and Atmospheric Administration (NOAA), and in partnership with Drexel University. The City also partnered with the Science Museum of Virginia and other partner organizations to conduct an

urban heat island study. For planning and prioritization purposes, climate impacts associated with increased temperatures, precipitation, and sea level rise were examined for three time horizons: 2030s, 2050s, and 2070s – sometimes described as near-term, mid-century, and late-century.

3.1 Virginia's Climate Impacts

The National Oceanic and Atmospheric Administration (NOAA) works to understand and predict changes in climate and weather and provides state-level summaries of these changes through its National Environmental Satellite, Data, and Information Service. The key climate impacts for Virginia are described to the right. As shown in Figure 3.1 Virginia's average temperatures have increased and will continue to do so, and future heat waves will be more intense. This will pose human health risks, particularly in metropolitan areas like Richmond. Cities have lower proportions of tree canopy, increased impervious surfaces, urban heat islands, and greater numbers of days of poor air quality. These conditions compound potential health effects of

Climate Impacts in Virginia

Warmer Average Temperatures	More Intense Droughts	More Extreme Heat and Precipitation
• Average annual temperature in Virginia has increased by about 1.5˚F since the beginning of the 20th century. • Under a higher emissions pathway, historically unprecedented warming is projected by the end of the 21st century.	• Naturally occurring doughts are projected to be more intense because higher temperatures will increase evaporation rates, depleting soil moisture more rapidly and adversely affecting agriculture.	• The number and intensity of extreme heat and extreme precipitation events are projected to increase. • Cold waves are projected to be less intense.

Source: Virginia State Climate Summary 2022

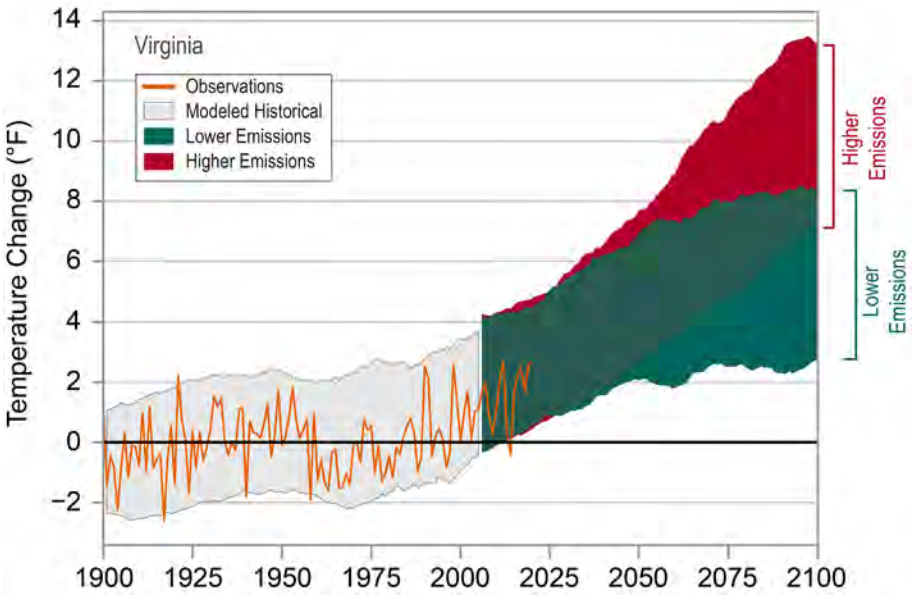


Figure 3.1. Observed and projected changes in near-surface air temperature for Virginia (Source: Virginia State Climate Summary 2022)

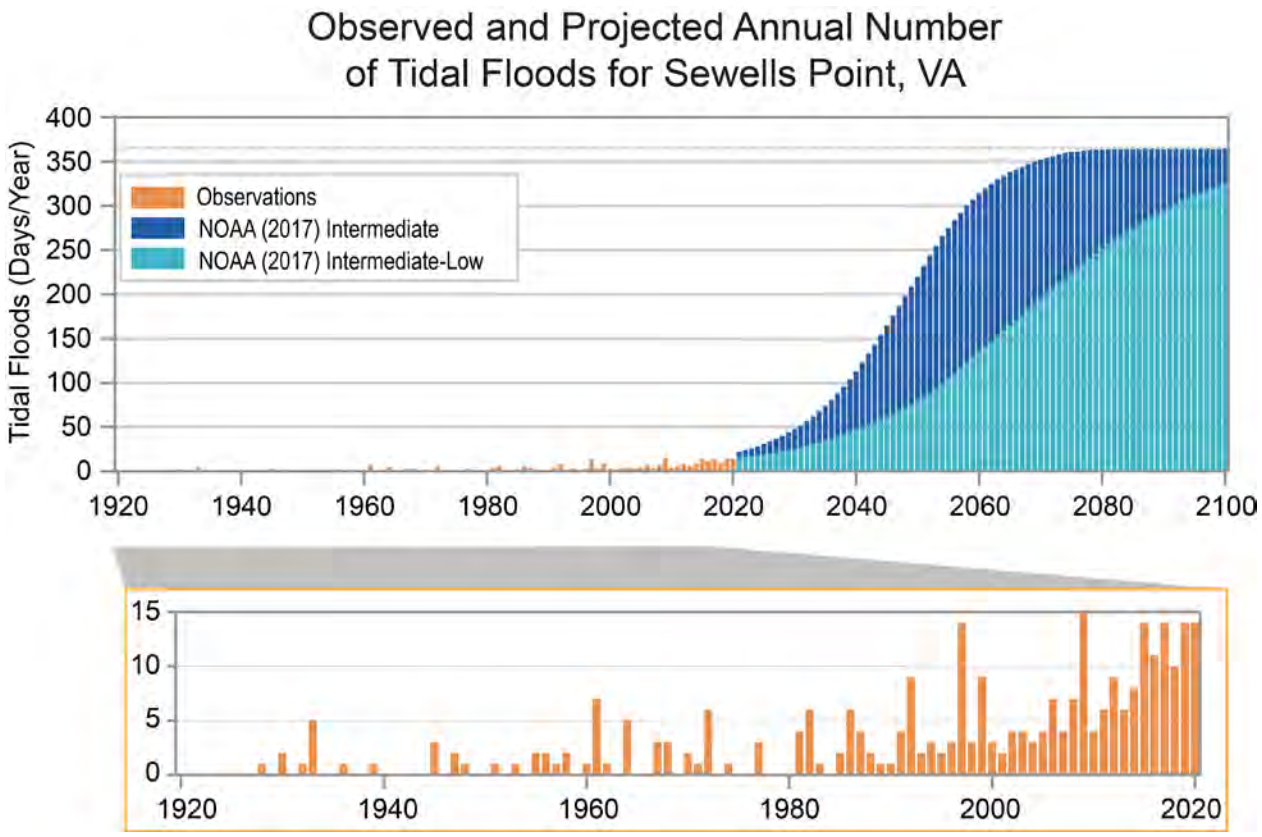


Figure 3.2. Number of tidal flood days per year for the observed record (orange bars) and projections for two possible futures: lower emissions (light blue) and higher emissions (dark blue) per calendar year for Sewell Point, VA. (Source: Virginia State Climate Summary 2022)

climate impacts for health and age-vulnerable community members.

Annual precipitation is projected to increase as well, in addition to the number and intensity of heavy precipitation events. Even as overall precipitation increases, naturally occurring droughts are projected to be more intense because precipitation will increasingly fall in high volumes for shorter periods, allowing for more extended periods with drier conditions, and higher temperatures will increase the rate of loss of soil moisture during dry spells.

During such periods, decreased water availability will likely have important implications for the state's agricultural economy.

Finally, Virginia is facing the impacts of sea level rise – at a greater rate than the rest of the world. Since 1880, global average sea level has risen by 7-8 inches. It has risen even more along the Virginia coast with a rise of 17 inches between 1930 and 2020 at Sewell's Point in Norfolk. Global sea level is projected to rise another 1 to 4 feet by 2100 as a result of both past and future emissions due to human activities, with greater rises possible along the Virginia coast following historical trends. This has caused and will continue to cause an increase in tidal floods and exacerbation of coastal storm surge, which damage infrastructure, cause road closures, and overwhelm storm drains.

3.2 Richmond's Climate Impacts

Like the state as whole, Richmond locally faces changing climate conditions including increasing temperatures, changing precipitation patterns, and rising sea level. These climate conditions cause climate impacts by creating more extreme precipitation and flooding events, extended heat waves, and extreme storm events. These impacts are already beginning to be felt in Richmond and are projected to increase in the future. All of these climate threats pose risks to Richmond's community members, infrastructure, and natural resources.

The following sections contain information on these climate impacts based on the latest science available. This information on historic climate trends, current climate conditions, and climate change projections helps in understanding what Richmond's future climate will look like and the climate risks and vulnerabilities that are evaluated in later portions of the assessment.

Modeling Climate Projections

Many of the climate projections included within this technical report utilize data from the World Climate Research Programme's Coupled Model Intercomparison Project Phase 5 (CMIP5) which helps to understand past and future climate changes (WCRP, 2021). The model includes different pathways or assumptions for future global greenhouse gas concentrations. In this assessment, many of the figures show future potential climate changes for both lower (RCP 4.5) and higher (RCP 8.5) emissions pathways modeled under CMIP5.

Emissions Scenario	2030	2050	2070
RCP8.5 (high)	72˚F	75˚F	77˚F
RCP4.5 (low)	72˚F	73˚F	74˚F

Table 3.2. Historic and projected annual average daily maximum temperature - Richmond (Source: Virginia State Climate Summary 2022)

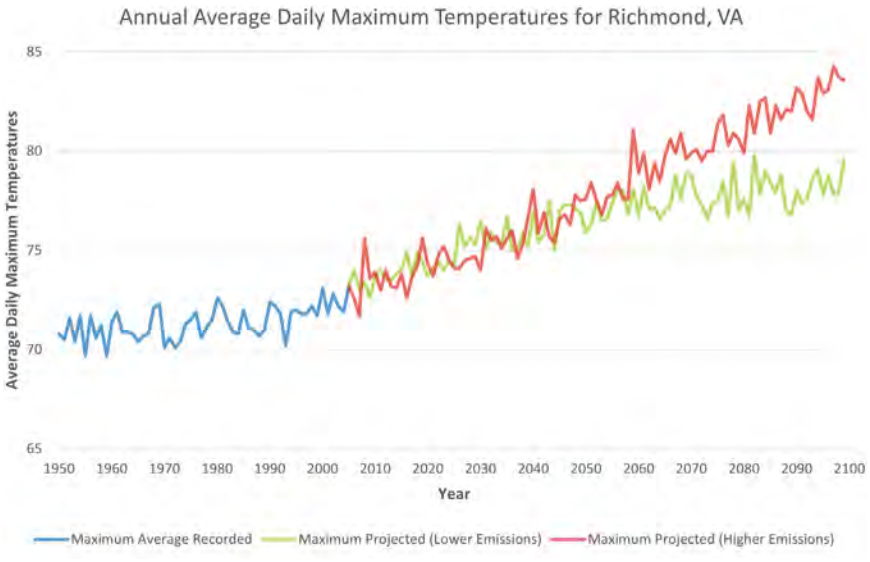


Figure 3.3 Annual average daily maximum temperature in Richmond – historical (blue) and projections under a lower (4.5) global emissions scenario (green) and a higher (8.5) global emissions scenario (red) (Source: U.S. Climate Resilience Toolkit)

3.2.1 Heat

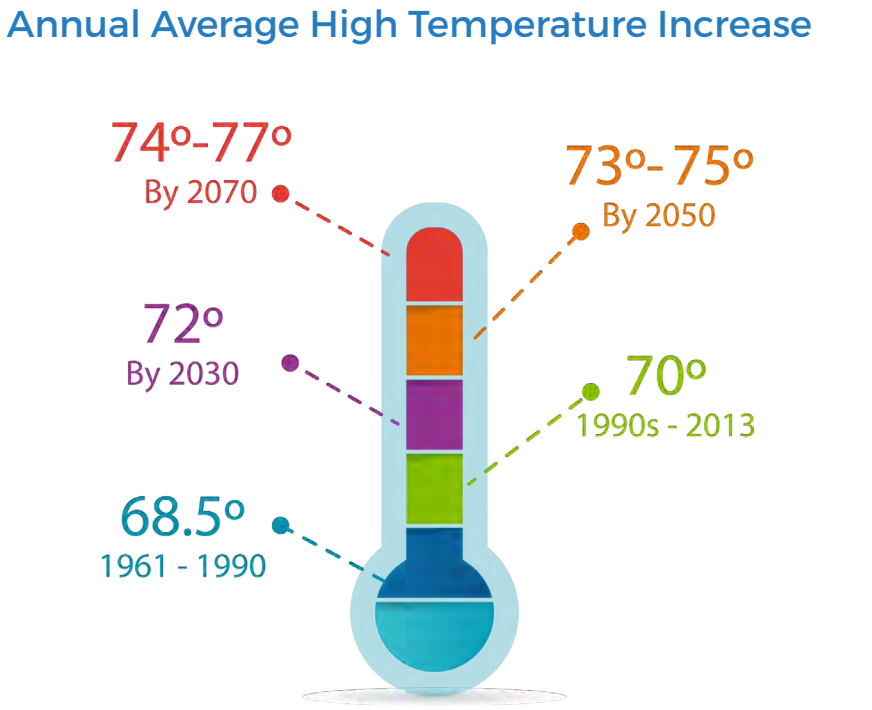
Annual Average High Temperature

The City of Richmond has already seen an increase in the annual average high temperature.

The observed average daily maximum temperature from 1961-1990 was 68.5˚F. The observed average in the 1990s was 69.8˚F and from 2000 to 2013, the observed average was 70.1˚F. Figure 3.3 provides projections for continued increases in average daily maximum temperature.

Days Above 95˚F

In addition to an overall upward trend in average temperature, there has also been an upward trend in the number of days above 95˚F.



Future temperature ranges reflect lower and higher global emissions scenarios. (Source data for the graphic: U.S. Climate Resilience Toolkit)

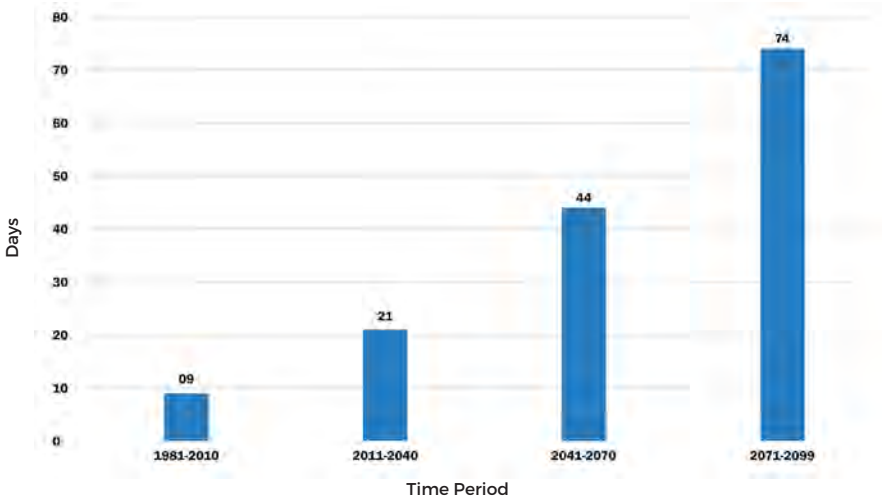


Figure 3.4 Historic and Projected Average Annual Number of Days with Temperatures over 95 degrees F for a High Emissions Future - Richmond, VA (Source: Mid-Atlantic Regional Integrated Sciences and Assessments)

Figure 3.4 provides projections for continued increases in the number of days above 95˚F. Figure 3.4 shows historic information for the City on streaks of consecutive days above 90˚F from 1970 to 2020.

Richmond is experiencing these high temperatures earlier in the spring and they are lasting later into the fall leading to longer summers, exacerbated drought conditions, and earlier and later, as well as more, heat waves. Higher temperatures are also leading to warmer nights on average as shown in Figure 3.5 for the period from 1970 to 2018, which becomes dangerous for public health when people, particularly in urban settings are not able to cool overnight. The City opens cooling stations during daytime hours when temperatures and/or heat indexes reach 95 degrees.

As reflected on the Daytime Warming Map, the impacts of hotter weather are not distributed evenly across Richmond. While the City as a whole is getting hotter, specific neighborhoods are experiencing greater temperature increases and urban heat island effects. Daytime warming is the difference between the morning temperature (6-7 am) and afternoon temperature (3-4

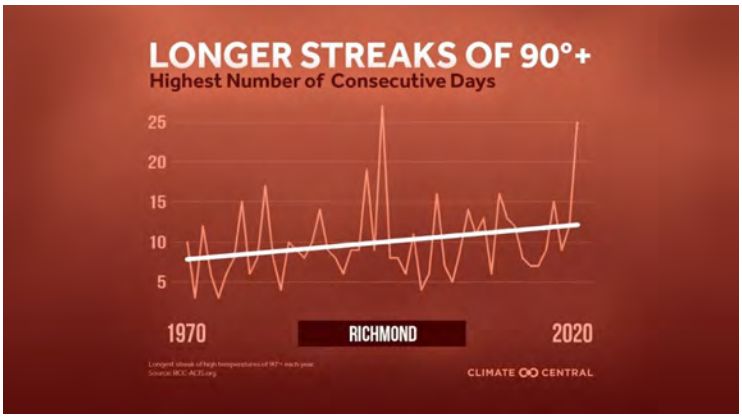


Figure 3.5 Annual days with maximum temperature above 90˚F in Richmond (Source: Climate Central)

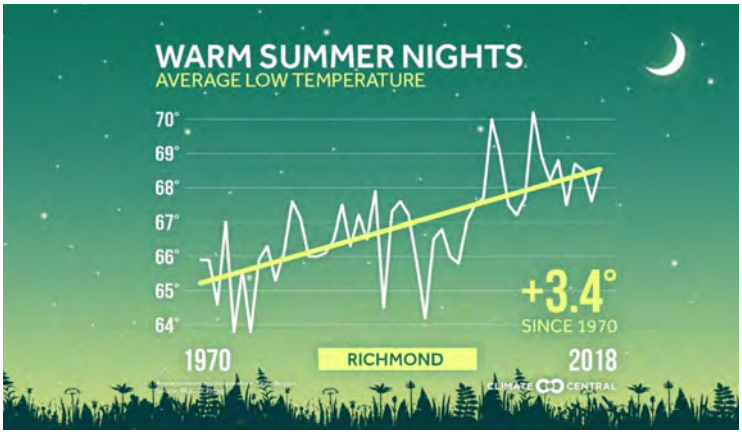
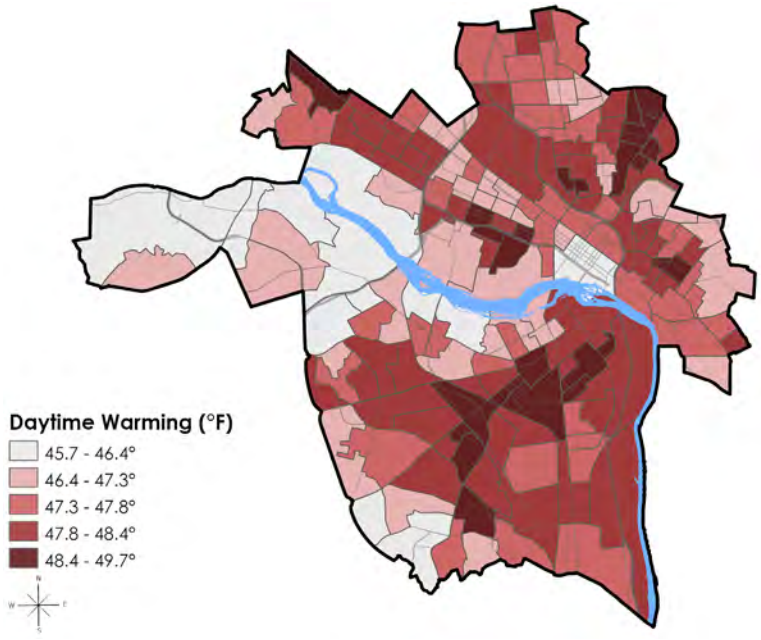


Figure 3.6 Annual Average Summer Night Low Temperature (Source: Climate Central)



Source: City of Richmond, US Census Bureau

pm) during the 2017 urban heat island study led by the Science Museum of Virginia. This is shaped by the amount of impervious surface, tree canopy, and green space present in various locations throughout the City. In Richmond, as in many other cities, climate heat effects are disproportionately impacting Black, Indigenous, and other communities of color, as explained in the Climate Equity Action Plan 2030 - Equity chapter.

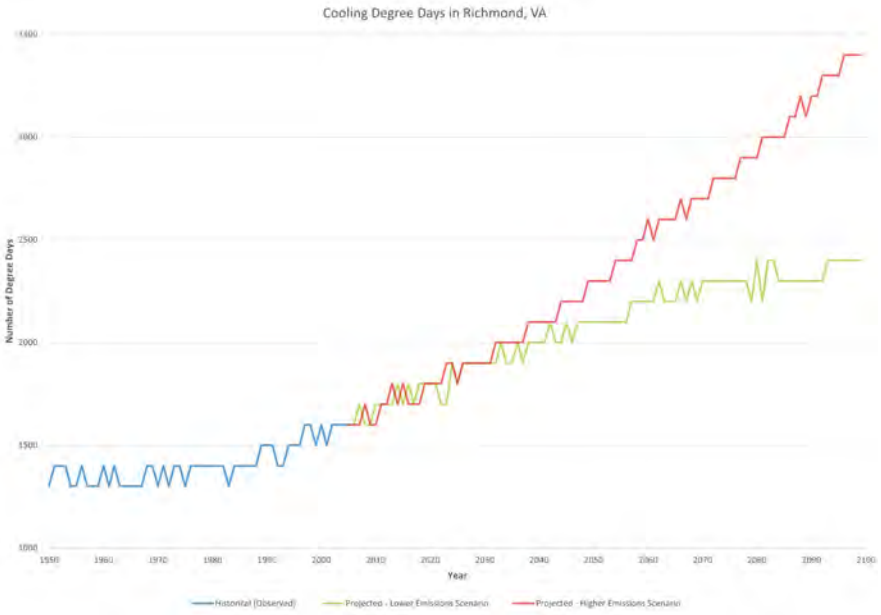
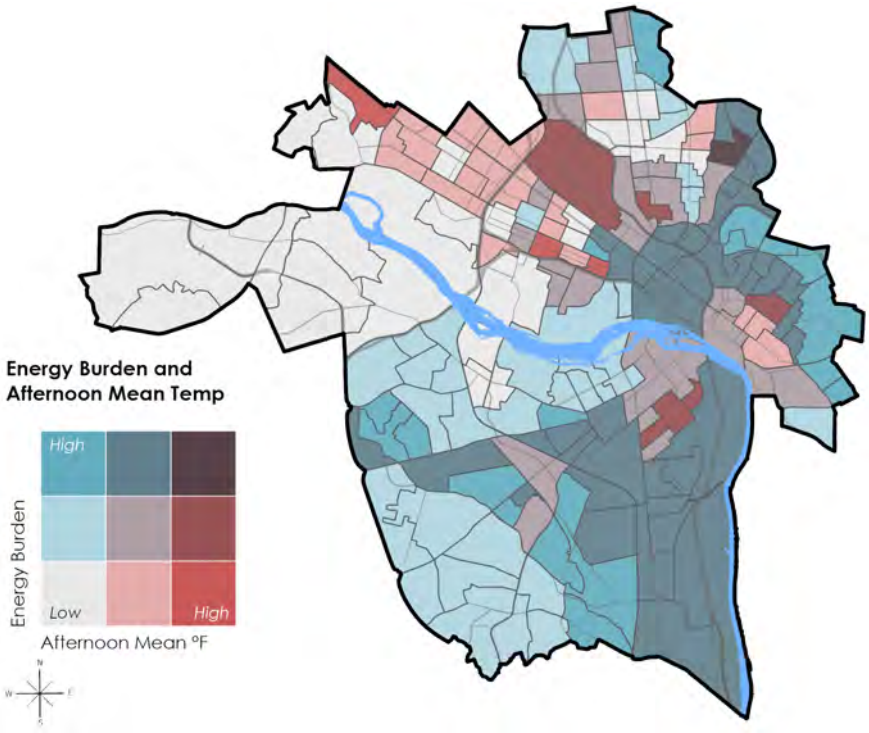


Figure 3.7 Annual cooling degree days in Richmond - historical (blue) and projections under a lower global emissions scenario (green) and a higher global emissions scenario (red) (Source: U.S. Climate Resilience Toolkit)

Cooling Degree Days

Cooling degree days measure how much (in degrees), and for how long (in days), outside air temperature is higher than 65˚F based on the average temperature each day. On a day when the average outdoor temperature is 85˚F, reducing the indoor temperature to 65˚F would require 20 degrees of cooling multiplied by 1 day, or 20 cooling degree days. The number of cooling degree days at any location reflects the amount of energy people use to cool a building when it is warm outside. Higher numbers of cooling degree days indicate a higher demand for energy.



Source: City of Richmond, U.S. Census Bureau

The number of cooling degree days has also been increasing and is projected to continue to increase in Richmond as illustrated in Figure 3.6 as high

temperatures continue to rise annually. Richmond's increasing temperatures and energy demand creates disproportionate burdens for the City's lower income residents as reflected on the Energy Burden and Afternoon Mean Temp Map. Energy burden represents the percentage of annual income that a household or individual pays towards their energy. A household is considered in "high burden" if they spend more than 6% of their annual income on energy bills - Richmond's average energy burden is 8.47%.

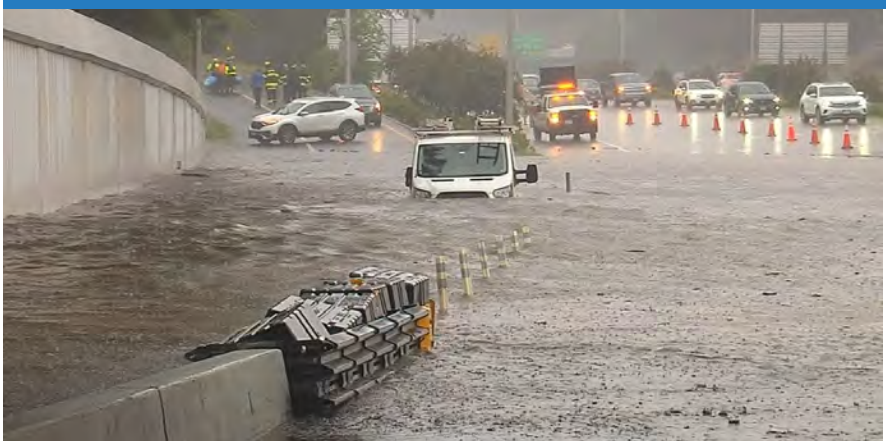
3.2.2 Precipitation

The City of Richmond has seen some historic increase in total annual precipitation and continued modest increases are anticipated.

Similar to the state of Virginia overall, Richmond has seen a somewhat greater increase in the amount of precipitation falling in heavy precipitation events compared with annual total precipitation trends. Figure 3.7 illustrates these historic trends and provide projections for continued increases in days per year with more than 1", 2", and 3" of precipitation in the City.

Precipitation and Storms

- Total annual precipitation will slightly increase
- Heavy rain events will become more frequent and more intense
- Severe storms will become more frequent
- Severe and extreme storm events will be more intense and cause more flooding



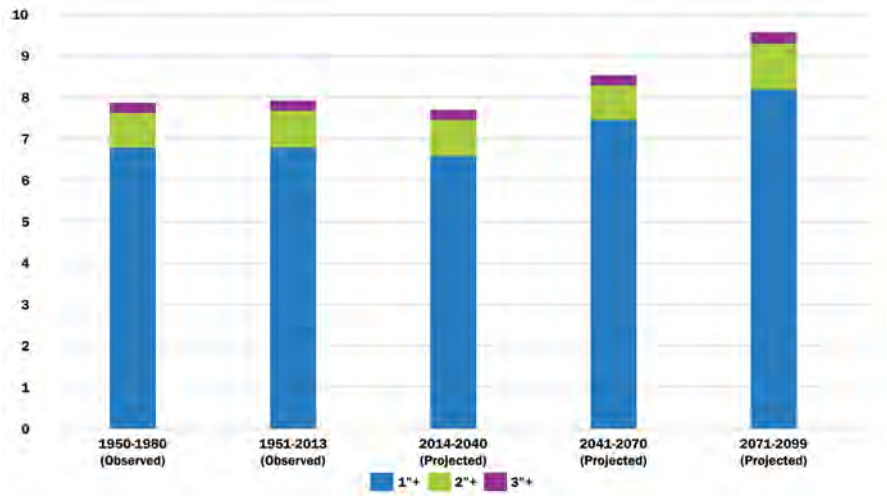


Figure 3.8 Historic and Projected Annual Days with >1, >2,>3 inches of Precipitation in Richmond (Source: U.S. Climate Resilience Toolkit)

Seasonal Precipitation

Figure 3.8 illustrates historic average seasonal precipitation from 1976 to 2005 and forecast seasonal precipitation in the near-, mid-, and long-term under lower (RCP4.5) and higher (RCP8.5) global emissions scenarios for Richmond as forecast under the Mid-Atlantic Regional Integrated Sciences and Assessments. Precipitation is anticipated to increase the most in winter and spring. A slight increase or decrease is anticipated in fall precipitation and little to no change in precipitation is anticipated during the summer.

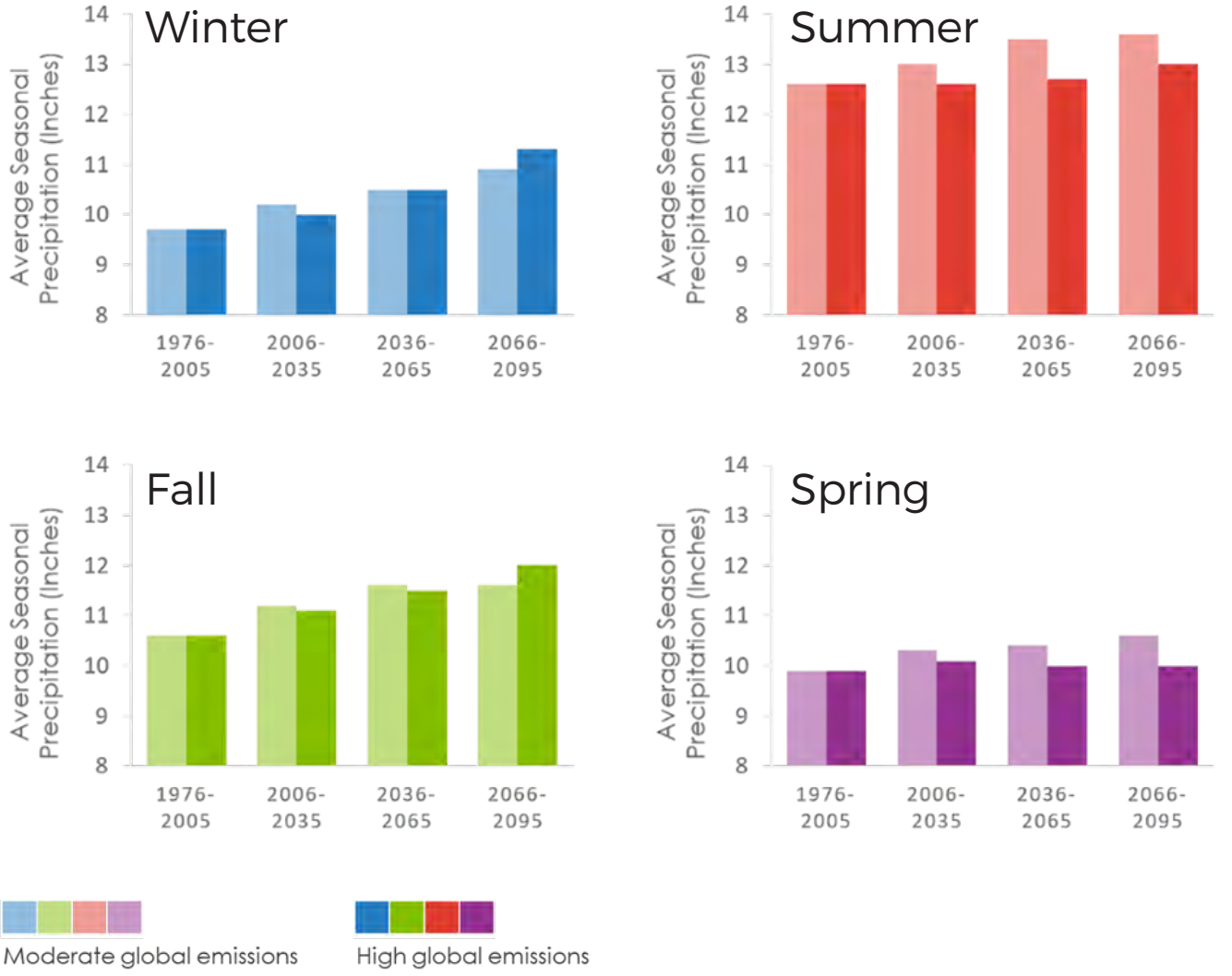


Figure 3.9 Historic and Projected Seasonal Precipitation by Emissions Scenario - Richmond, VA (Source: Mid-Atlantic Regional Integrated Sciences and Assessments)

The City worked with Drexel University to create a more refined model for changes in seasonal precipitation for Richmond. Figure 3.9 shows the percent change in seasonal precipitation in the 2050s and 2080s under a blended scenario between the moderate and high emissions scenarios. Under this analysis, a greater increase in summer precipitation was identified when compared with the Mid-Atlantic Regional Integrated Sciences Assessments forecasts. Figures 3.10 and 3.11 illustrate these anticipated changes in rainfall depth for the 2050s and 2080s for the winter (highest change), spring (lowest change), and fall (average change) scenarios. As a baseline, the charts also illustrate projections from NOAA Atlas 14, which provides the official estimate of precipitation frequency for the United States. Climate models are complex and entail some level of uncertainty, thus there are some variations. However, all of the forecasts show that storms affecting the Richmond area are expected to become more intense in the future, with higher rates of runoff and increased flooding.

Season	2050s	2080s
Winter (Dec-Feb)	11.3%	15.2%
Spring (Mar-May)	3.8%	5.9%
Summer (Jun-Aug)	4.6%	5.1%
Fall (Sep-Nov)	0.7%	0.8%

Figure 3.10 Delta Change Factors (increases over historical conditions) in seasonal precipitation for Richmond – projections under a blended (moderate and higher) global emissions scenario

Source: City of Richmond, Drexel University

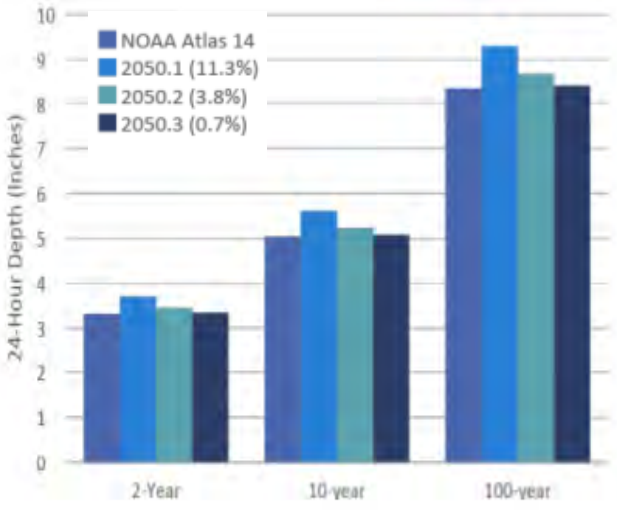


Figure 3.11 2050 Rainfall Projections for 2-, 10-, and 100-year (50%, 10%, 1%) Design Storms Under NOAA Atlas 14 Compared to Various Global Climate Models (Source: City of Richmond, Drexel University)

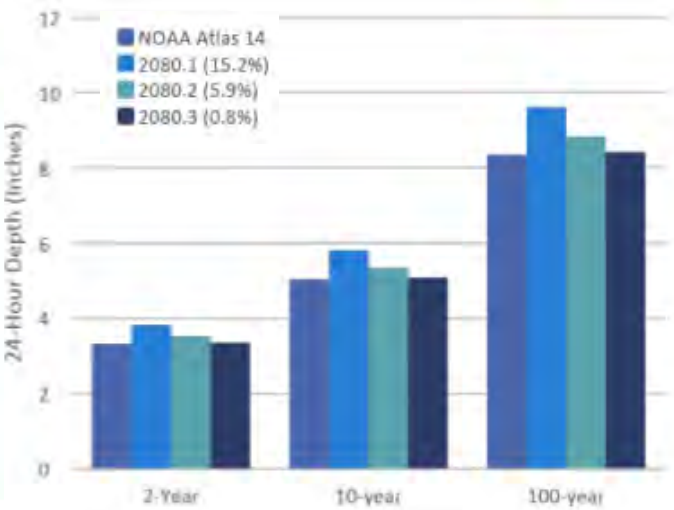


Figure 3.12 2080 Rainfall Projections for 2-, 10-, and 100-year (50%, 10%, 1%) Design Storms Under NOAA Atlas 14 Compared to Various Global Climate Models (Source: City of Richmond, Drexel University)

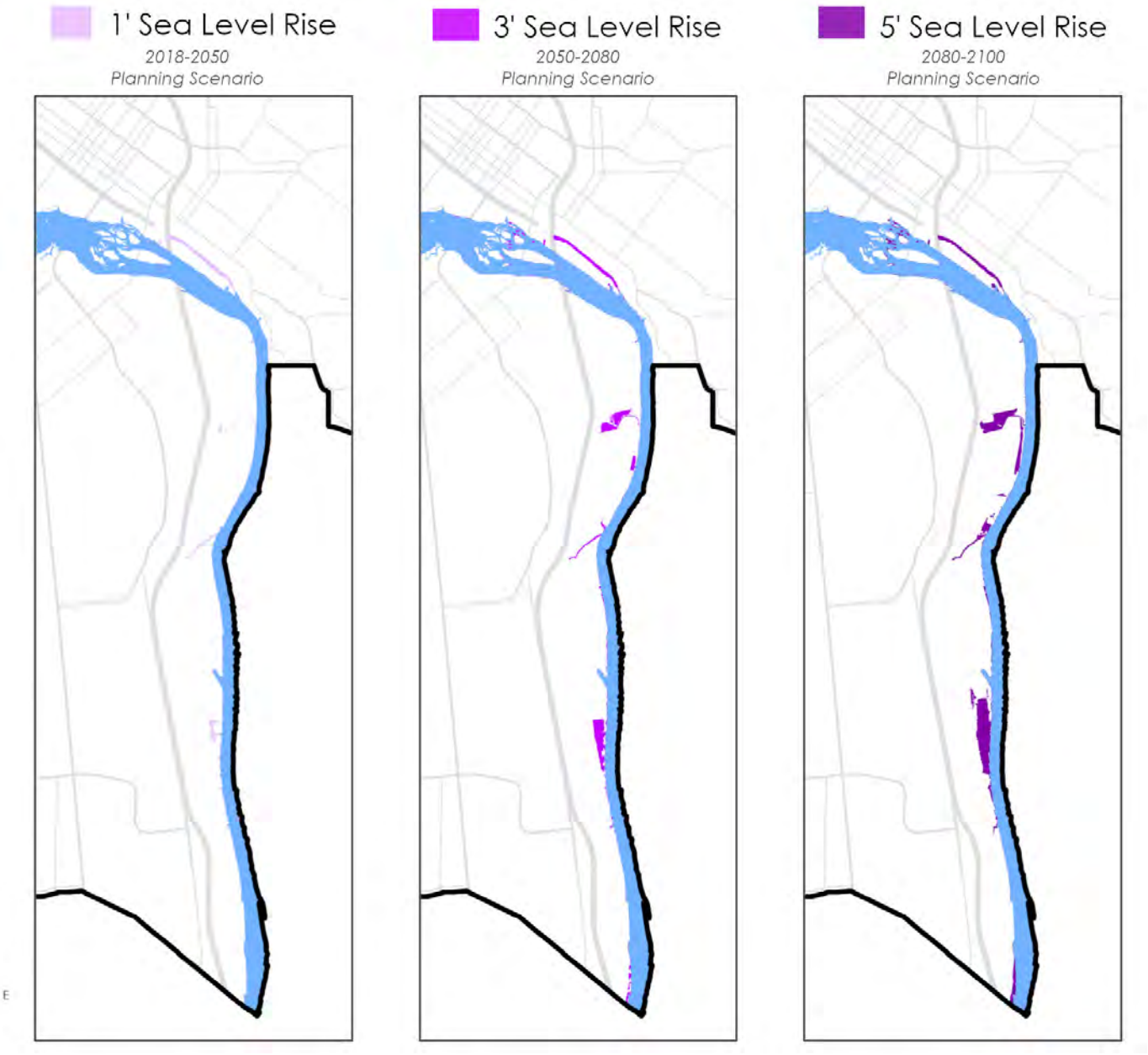
3.2.3 Sea Level Rise

As described earlier, Virginia is facing the impacts of sea level rise at a greater rate than the rest of the world. Over the last century, the sea level has risen nearly twice as much along the Virginia coast than the global average. Richmond will be impacted by sea level rise as it causes rising river levels upstream to the James River fall line at the 14th Street/Mayo Bridge. (Virginia Department of Game and Inland Fisheries) The exact amount of sea and river level rise depends on global emissions, but guidance from the Hampton Roads Planning District Commission's Sea Level Rise Planning Policy and Approach provided a starting point for the City for planning purposes. The Hampton Roads policy recommends using three sea level rise scenarios associated with future planning timeframes. For City of Richmond, the following sea level rise scenarios were identified:

- 1' above current mean higher high water (MHHW) for near-term (2018-2050)
- 3' above current mean higher high water (MHHW) for mid-term (2050-2080)
- 5' above current mean higher high water (MHHW) for long-term (2080-2100)

Source: City of Richmond, NOAA

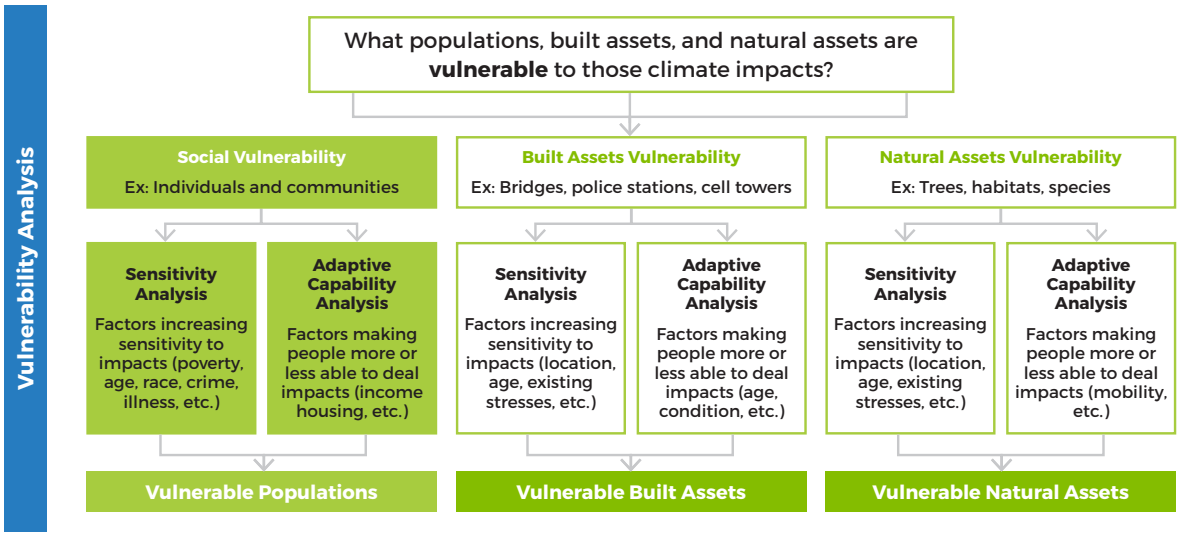
These sea level rise scenarios have been applied to the James River using the National Oceanic and Atmospheric Administration (NOAA) Sea Level Rise Viewer tool. The data used to create the maps below includes areas that have a high degree of confidence, or low uncertainty, representing locations that will be correctly mapped (either as inundated or dry) more than 8 out of 10 times, or in other words there is an 80 percent degree of confidence that these areas are correctly mapped. Areas mapped by NOAA as dry or wet with a low confidence or high uncertainty were removed from these maps. Sea level rise will have a relatively minor impact on Richmond for the next century, especially when compared to the potential impacts of heat and precipitation. However, it is important to consider the impact of sea level rise for various industrial uses located in impacted areas – this is discussed further in the vulnerability and risk sections. In addition, sea level rise projections may change over the coming years or increase in future centuries and should be monitored closely.



Source: City of Richmond, NOAA

4. Social Vulnerability

Once future climate impacts have been identified, the next step in the assessment process is to identify the populations, built assets, and natural assets that may be vulnerable to these climate impacts.



The first element in this step is determining social vulnerability. Social vulnerability is focused on people and their ability to withstand and respond to stressors like the impacts of climate change. The approach to social vulnerability analysis is described in the sections that follow. The results of this analysis will be integrated with the analysis of vulnerabilities of built and natural assets in Section 5 to understand how impacts to those resources may affect communities and inform prioritization of vulnerabilities to address through climate resilience strategies. For example, if a building is vulnerable to flooding, this analysis helps to understand how people who live in or work in, or otherwise use the building, are likely to be affected by that flooding, with a particular focus on potential impacts to socially vulnerable populations.

4.1 Variable Selection

The Social Vulnerability Index (SVI) developed by the U.S. Centers for Disease Control (CDC) uses 15 census variables to identify communities that may need support in preparing for hazards (CDC, 2015). The SVI serves as the foundation for the variables used in this vulnerability assessment. Additional variables were added based on best practices research and examples of similar assessments in peer cities. Each of the resulting 39 factors may increase an individual's or community's vulnerability to the impacts of climate change in Richmond – heat, precipitation, and sea level rise – as explained below. More detailed descriptions and information sources for each factor are included in Appendix A.

Population Factors	
Elderly (65+)	For individuals 65 years of age or older, climate change impacts worsen the risks of certain diseases and disorders, and can increase susceptibility to heat, pollutants, and vector-borne diseases. Climate impacts can also cause changes in various social factors such as income loss and social isolation.
Children (under 18)	Having little or no direct control over the environment they live in, children under 18 have an increased vulnerability to the impacts of climate change, and can require additional care and protection from harm. Children under 18 are also more susceptible to traumatic events that can result in long-term negative effects on health, social, and behavioral outcomes
Minorities (race & ethnicity)	Minority groups tend to live in more marginal and exposed areas that have an increased susceptibility to climate impacts, as well as higher morbidity and mortality rates associated with impacts such as extreme heat.
Female	Women exposed to climate change impacts, such as poor air quality, have higher risks than men for increased cases of air particulate matter in lung tissue and anemia. Poor air quality is also associated with negative birth outcomes, and poses a risk for maternal and child health associated with stillbirth, intrauterine growth restriction, and congenital defects.
Limited English Proficiency	Individuals with limited English proficiency (LEP) have high poverty rates, various language and cultural barriers such as accessing and affording mental health care, and limited counseling in native languages, which reduces their climate change adaptability and resilience.

Health & Safety Factors	
Health Opportunity Index	The Health Opportunity Index (HOI) is a measurement based on 13 indicators that reflect a wide variety of social determinants of health in order for individuals to live a long and healthy life. A low health opportunity index can indicate poor air quality, income inequality, low education levels, limited access to care, and poor food accessibility, which are all factors that increase vulnerability to the impacts of climate change.
Disabilities	With greater susceptibility to invasive diseases, and the complex disability-related challenges of evacuation and relocation, individuals with physical and mental disabilities have an increased vulnerability during storms, floods, and extreme heat. Persons with mobility or cognitive impairments are likely to experience greater vulnerability to health risks due to difficulty responding to, evacuating, and recovering from extreme events.
Obesity	Climate change impacts such as extreme heat events can increase the risk of heat exhaustion and mortality for those who are obese. In a climate-related emergency situation, individuals with severe or morbid obesity may face challenges in regards to rescue, evacuation, transport, and suitable equipment.
Diabetes	Higher ambient temperature can negatively impact glucose metabolism, increasing the incidence of diabetes as temperatures rise due to climate change. In addition, people with diabetes experience increased complications in hotter temperatures, including dehydration, heatstroke, and cardiovascular events.
Asthma	Climate change causes an increase in ozone pollution; coupled with greater concentrations of carbon dioxide and higher temperatures, pollen quantity may increase and induce longer pollen seasons. Ozone and pollen can worsen existing respiratory allergies and asthma, and serve as triggers for asthma attacks.
Chronic Obstructive Pulmonary Disease (COPD)	Individuals with COPD face increased mortality, higher rates of hospitalization and exacerbation of COPD symptoms, and a worse quality of life. The air pollutants that cause climate change exacerbate existing and cause new cases of respiratory diseases. Individuals with COPD face increased respiratory symptoms, increased rescue inhaler use, and decreased lung function.

Health & Safety Factors	
Coronary Heart Disease	Large day-to-day variations in temperature can cause individuals with coronary heart disease to have significantly more heart attacks. For every 5-degrees Celsius jump in temperature, the risk of a heart attack increases by roughly 5 percent.
High Blood Pressure	Variations in temperature can cause changes in blood pressure, and may lead to severe drops in blood pressure, increasing the risk of collapsing in older adults. Blood pressure medication can interfere with an individual's ability to self-regulate body temperatures, increasing their risk of vulnerability to climate change impacts like excessive heat.
Kidney Disease	During heat waves there is an increase in hospital admissions for acute kidney injury, and kidney failure becomes a leading cause of premature death. Dialysis patients are among the most vulnerable during natural disasters due to the potentially life-threatening impact of missed dialysis.
Mental Health (Self-Assessed)	For those with mental health issues and stress, the impacts of climate change pose significant risks for factors such as PTSD, depression, general anxiety, suicidal thoughts, and increased substance abuse. Also, excessive heat serves as a risk for individuals taking medication for mental health, due to the medication's ability to interfere with self-regulating body temperatures.
Physical Health (Self-Assessed)	Self-assessed health is increasingly being considered as a valid measure for predicting future health outcomes among elderly individuals. Older people who assess their physical health less favorably, have shown a significant correlation with functional decline and mortality. Individuals with poor physical health have difficulty responding to, evacuating, and recovering from extreme events.
Uninsured	Those who are uninsured have lower rates of health care use and experience worse health outcomes, including increased rates of mortality, and may require extra resources to prepare, evacuate, and recover from emergency situations and the impacts of climate change.
Food Access	In most cities neighborhoods are not equally served by the same number of food retail stores, which increases food security vulnerability. Individuals with low food access may have to settle for inadequate options as prices increase due to declining crop yields, livestock, and fish production, and affordable food options become limited. This map identifies the low-income census tracts within Richmond where more than 100 housing units do not have a vehicle and are more than a ½ mile from the nearest supermarket

Health & Safety Factors

Crime	There is a strong relationship between temperature and both violent and property crime. With extreme heat, the likelihood of physical aggression and violence rises due to an increase in perceived hostility, anger, and irritability. Disadvantaged neighborhoods will experience higher levels of such violence.

Household Factors

Single Parent Households	Single parent households are more likely to be in poorer neighborhoods and have fewer economic resources. With the sole responsibility for caregiving as well as providing family income, this increases their vulnerability to the impacts of climate change.
Custodial Grandparents	Custodial grandparents have been shown to have higher levels of obesity, hypertension, heart disease, limited physical functioning, and dissatisfaction with one's physical health. Additionally, custodial grandparents have reported emotional stress from financial constraints, and inadequate social support which make them vulnerable to the impacts of climate change.
Renters	Renters have a low climate change adaptability and resilience, given the low quality and short supply of available housing, as well as the renter's limited ability to retrofit their place of residence to prepare for climate change. Additionally, renters new to an area have less knowledge of local environmental hazards, such as floods, which reduce their ability to adapt to climate impacts.
Elderly Isolation	Individuals who are 65-years of age or older and alone are more likely to have limited ability to evacuate due to a disability, limited income, lack of transportation, or lack of social support from family and friends. Older Americans living alone may be more susceptible to risks such as frauds or scams, regarding home improvements or repairs before or after extreme weather events.

Income & Education Factors	
Poverty	Individuals below the poverty level are more likely to depend on climate sensitive forms of employment, such as agriculture, or on low-income informal or hourly jobs. The impacts of climate change can cause a rise in risks such as physical and mental illnesses, job loss, and decreased food security. Additionally, those below the poverty level have fewer resources and receive less support, which reduces their ability to prevent, cope, and adapt to climate change impacts.
Work Outdoors	Climate change impacts serve as risks to outdoor workers through increases in temperature, poor air quality, extreme weather, diseases transmitted by ticks and mosquitoes, industrial exposures, and damage to infrastructure. Extreme heat may result in more heat-related illnesses such as heat stroke, heat exhaustion, and fatigue for outdoor workers
SNAP/Food Stamps	Individuals who receive SNAP/food stamps in areas of low food security have limited adaptability and resilience to the impacts of climate change. Disruptions in government functions during climate disasters may impact distribution of SNAP/food stamp benefits, and individuals may have to opt for non-nutritious food options.
Public Assistance Income	Climate change induced natural disasters may disrupt communication systems and pose risks to the distribution of governmental benefits. For climate resilience, public assistance income must be able to change as the demand changes, while facing the challenge of slower economic growth.
Housing Cost Burden (>30% of HH income)	Households with housing expenditures that exceed 30 percent of household income are considered financially burdened, which can limit household consumption, reduce economic mobility, and reduce climate adaptability and resilience.
No High School Diploma	Education levels are highly correlated with access to weather forecasts and warnings, as well as the types of technologies used to access weather information. Without adequate access to information, individuals cannot respond and prepare for hazards effectively.
Unemployment	Individuals who are unemployed will have a harder time relocating from areas impacted by climate change, and may lack resources to repair or rebuild their home in the event of a natural disaster.

Income & Education Factors

Housing Choice Voucher Program	The Housing Choice Voucher Program provides rental assistance to qualified low-income individuals and families to afford decent, safe, and sanitary housing. However, the largest concentration of renters using Housing Choice Vouchers is located in subsidized housing projects, which intensifies poverty to those locations. Residences with low economic standing are associated with poorer health care access, being uninsured, and higher hospitalization rates, which limits climate adaptability and resilience.

Housing & Transportation Factors

Multi-Unit Structures	Multi-Unit Structures: Multi-unit structures are buildings containing 10 or more housing units. Individuals living in multi-unit housing have limited access and limited ability to leave the building to obtain food, medicine, and other needed services. In multi-unit structures where residents rely on elevators, electricity loss makes it difficult if not impossible for some residents to evacuate, especially the elderly and those with disabilities.
Mobile Homes	Mobile Homes: Mobile homes are often isolated with limited or no access to public transportation or highways, limiting their ability to evacuate. The impacts of climate change may result in many of the mobile home parks experiencing a significant destruction of personal property and displacement of their residents.
Crowding	Crowding: Crowding, where there are more people than rooms in a household, increases psychological distress, and can contribute to the spread of communicable diseases among residents. Children are especially vulnerable, as the lack of a comfortable, quiet space can lead to difficulties studying and reading, affecting school performance and increasing social withdrawal. All of these factors can increase the vulnerability of members of a crowded household to climate impacts.
Vehicle Access	Transportation Access: Individuals in a household without a vehicle have a limited ability to evacuate or move to an area of refuge during a climate change impact, such as an air-conditioned cooling center during extreme heat, or a shelter during severe flooding.

Housing & Transportation Factors	
Air Conditioning	Air Conditioning: Climate change impacts, such as extreme heat, are associated with an increased risk of mortality from respiratory, cerebrovascular, and some specific cardiovascular diseases such as ischemic heart disease, congestive heart failure, and myocardial infarction. Extreme heat can also increase the risk of heat exhaustion and heat stroke, therefore without a central AC have a low climate change adaptability and resilience.
Homelessness	Homelessness: Homelessness is associated with both racial and ethnic disparities, and children experiencing homelessness have a 25% greater risk of poor health and higher mortality rates in adulthood, increasing vulnerability to climate impacts. Climate-related disasters lead to displacement, which increases the need for emergency and transitional shelters, and causes greater exposure to health risks.
Adult Group Homes	Adult Group Homes: Group homes and residential treatment centers are facilities that may offer housing, and provide personal care and medical services for adults. Group homes often service the elderly and individuals with disabilities, which increases their vulnerability. A climate-related disaster may result in power outages that can limit communication for emergency services, and severely impact those who rely on refrigerated mediations, or use life-sustaining equipment.
Internet Access	Internet Access: Access to the internet is a crucial resource for connecting people to the information they need in areas such as emergency services, education, employment, and health. Without access to internet, through either a home-based or cellular data subscription, households may be limited in their access to this information and be more vulnerable to sudden and dangerous increases in temperature or flooding.

A review of peer cities' climate vulnerability assessments revealed that this is a greater number of variables than is typically used to measure social vulnerability to climate change. The aim of this approach is to provide a more comprehensive picture of vulnerability. In addition, the intention is that by gathering this data as part of this project, it can serve multiple purposes for both internal City of Richmond as well as external community audiences. A certain factor, while possibly having a small impact on a neighborhood's aggregate vulnerability score, could help with implementation of climate resilience strategies in the future. For example, the City and partner organizations could see where to prioritize air conditioning assistance programs based on the economic and central air conditioning data, or the data on outdoor workers could be used to target populations for education on heat-related illness prevention.

The table below lists the data sources and attributes for analysis for each of the social vulnerability factors. The factors are divided into two groups: sensitivity factors, which affect the degree to which a person, household, or community is directly or indirectly affected by changes in climate conditions or climate change impacts; and, adaptive capacity factors, which affect the ability of a person, household, or community to accommodate changes in climate with minimal potential harm or cost. Poverty is the only factor that was used in both the sensitivity and the adaptive capacity analyses because it has such a significant impact on a person's ability to withstand and deal with shocks.

Social Vulnerability Sensitivity and Adaptive Capacity Factors

Sensitivity Factors		
Factor	**Source**	**Attribute for Analysis**
Poverty	2012-16 ACS[1]	Percent of individuals below poverty level in the past 12 months
Public Assistance	2012-16 ACS	Percent of households receiving public assistance income in past 12 months
Food Stamps	2012-16 ACS	Percent of households receiving food stamps/SNAP
Non-White	2012-16 ACS	Percent of individuals that are not white
Elderly	2012-16 ACS	Percent of individuals 65 or older
Children	2012-16 ACS	Percent of individuals under 18
Female	2012-16 ACS	Percent of individuals that are female
Disabilities	2009-13 ACS	Percent of individuals with a disability (hearing, vision, cognitive, ambulatory, self-care, or independent living difficulty)
Obesity	CDC (2015)	Percent of adults with obesity
Asthma	CDC (2015)	Percent of adults with asthma
COPD	CDC (2015)	Percent of adults with COPD
Heart Disease	CDC (2015)	Percent of adults with coronary heart disease

High Blood Pressure	CDC (2015)	Percent of adults with high blood pressure
Kidney Disease	CDC (2015)	Percent of adults with chronic kidney disease
Mental Health	CDC (2015)	Percent of adults self-reporting mental health not good for more than 13 days
Physical Health	CDC (2015)	Percent of adults self-reporting physical health not good for more than 13 days
Food Access	USDA[2]	Percent of population beyond 1 mile from a "supermarket," as defined by USDA
Grandparent Householder	2012-16 ACS	Percent of population under 18 living with grandparent householder
Single Parent Household	2012-16 ACS	Percent of population under 18 living with one parent
Work Outdoors	2012-16 ACS	Percent of population in workforce working in sectors: Natural resources, construction, and maintenance occupations: Farming, fishing, and forestry occupations; Construction and extraction
Housing Costs	2012-16 ACS	Percent of households where monthly housing costs are 30% or more of household income
Multi-Unit Structure	2012-16 ACS	Percent of housing units in a structure with 10 or more total units
Mobile Home	2012-16 ACS	Percent of housing units that are mobile homes, boats, or RVs
Crowding	2012-16 ACS	Percent of housing units with more than 1 occupant per room
Crime	RPD[3]	Crime rate per person for all crimes between 11/20/2013-11/20/2018
Adaptive Capacity Factors		
Factor	**Source**	**Attribute for Analysis**
Poverty	2012-16 ACS	Percent of individuals below poverty level in the past 12 months
Unemployment	2012-16 ACS	Percent of population 16 and over unemployed
High School Diploma	2012-16 ACS	Percent of population over 25 without a high school diploma
Limited English Proficiency	2012-16 ACS	Percent of households with limited English proficiency (speaking English Less than Very Well)
Elderly Living Alone	2012-16 ACS	Percent of population 65 and over living alone
Renters	2012-16 ACS	Percent of housing units occupied by renters
Vehicle Access	2012-16 ACS	Percent of households with no vehicle available

Internet Access	2013-17 ACS	Percent of households without an internet subscription (includes dial up, satellite, broadband, cellular data plan)
Central Air Conditioning	City of Richmond Assessor (2018)	Percent of households without central air conditioning
Housing Choice Vouchers	HUD[4]	Percent of renter-occupied housing units with Housing Choice Vouchers
Shelters/ Emergency Housing	2010 Census	Percent of individuals in emergency and transitional shelters (with sleeping facilities) for people experiencing homelessness
Group Homes	2010 Census	Percent of individuals in group homes intended for adults or residential treatment centers for adults
Uninsured	2012-16 ACS	Percent of population without health insurance coverage
Health Opportunity Index	Richmond 300	Overall Health Opportunity Index as designated by Virginia Department of Health's Office of Minority Health and Health Equity

[1] American Community Survey
[2] USDA Food Access Research Atlas
[3] City of Richmond Police Department
[4] U.S. Department of Housing and Urban Development

4.2 Analysis of Social Vulnerability

Based on social vulnerability assessment methodologies from several peer cities, the 39 factors described above were used in two different ways to determine which census tracts in Richmond are the most vulnerable to climate change.

4.2.1 Analysis Methods

Quartile Method

Following the methodology described in several peer city vulnerability assessments, including Somerville and Washington, DC, Census tracts were ranked for each of the 38 factors and then divided into quartiles. The tracts were assigned a score between 1 and 4 based on their quartile. Then these scores were added across all 38 factors for each tract to create an aggregate vulnerability score.

Standard Deviation Method:

Following the methodology described in the Minneapolis vulnerability assessment, Census tract values were converted to z-scores using the average and standard deviation of all tracts for each of the 38 social vulnerability factors. A standard deviation classification number, or score, was assigned based on the categories below. Within this scoring system, a score of 1 indicates the lowest relative vulnerability and 6 indicates the highest. These scores were added across all 38 factors, then the total scores were converted to z-scores and assigned an aggregate score of 1 to 6 using the same system below.

The final vulnerability map contained in this report depicts the results of the standard deviation method described above. There were minimal differences between results of the two methods, and standard deviation is generally thought of as a more robust measure of dispersion among multiple variables.

4.2.2 Additional Analysis Methods

Two additional steps were taken to assess the validity of the methodology described above: a reduced-factor analysis and a principal component analysis. In the reduced-factor analysis, a set of 12 factors was taken from the 38 described above and put into both the quartile and standard deviation methods of ranking vulnerability. The 12 factors were identified as those commonly used by peer cities and best practices guides for vulnerability assessments.

This analysis revealed only minor differences in the final vulnerability ranking of census tracts from the results of the use of 38 factors.

In addition, a correlation matrix and principal component analysis were created using the statistics software R.

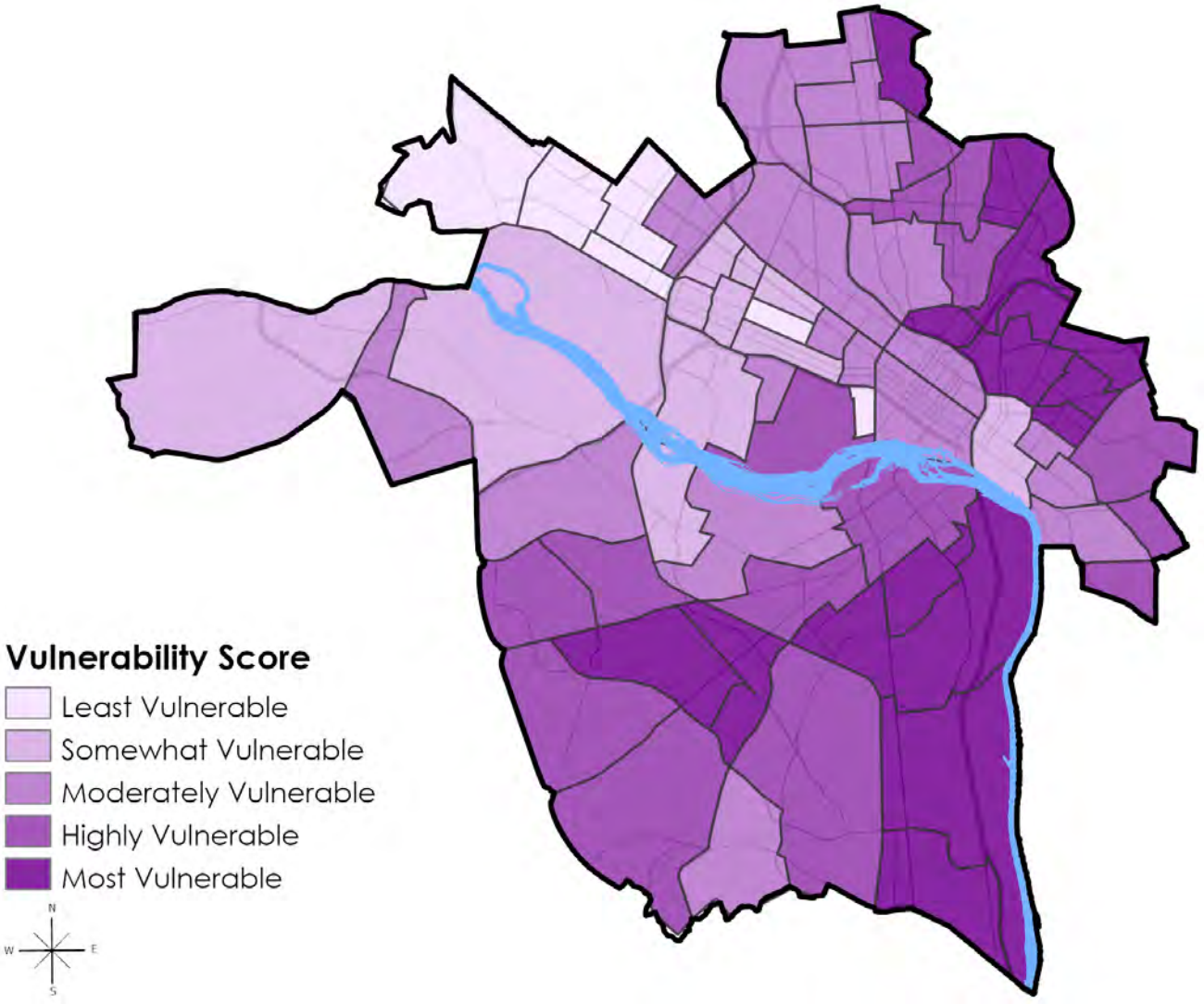
The purpose of this step was to attempt to identify potential correlations between the 38 factors that may skew the results of the scoring method. This step identified a few cases where some of the 38 variables may be so interrelated as to not have significant impact on the analysis, though no perfect positive correlations were revealed. However, as noted in the Minneapolis vulnerability assessment methodology, this process is overly complicated to perform and explain to the public, and therefore was not used to alter the final method and map. Online tutorials and information from the Minneapolis vulnerability assessment report were used to complete these steps.

Appendix B contains tables and charts with the results of the correlation matrix and principal component analysis.

4.3 Composite Social Vulnerability Mapping

Maps were created for each of the 39 factors based on their actual values as described below.

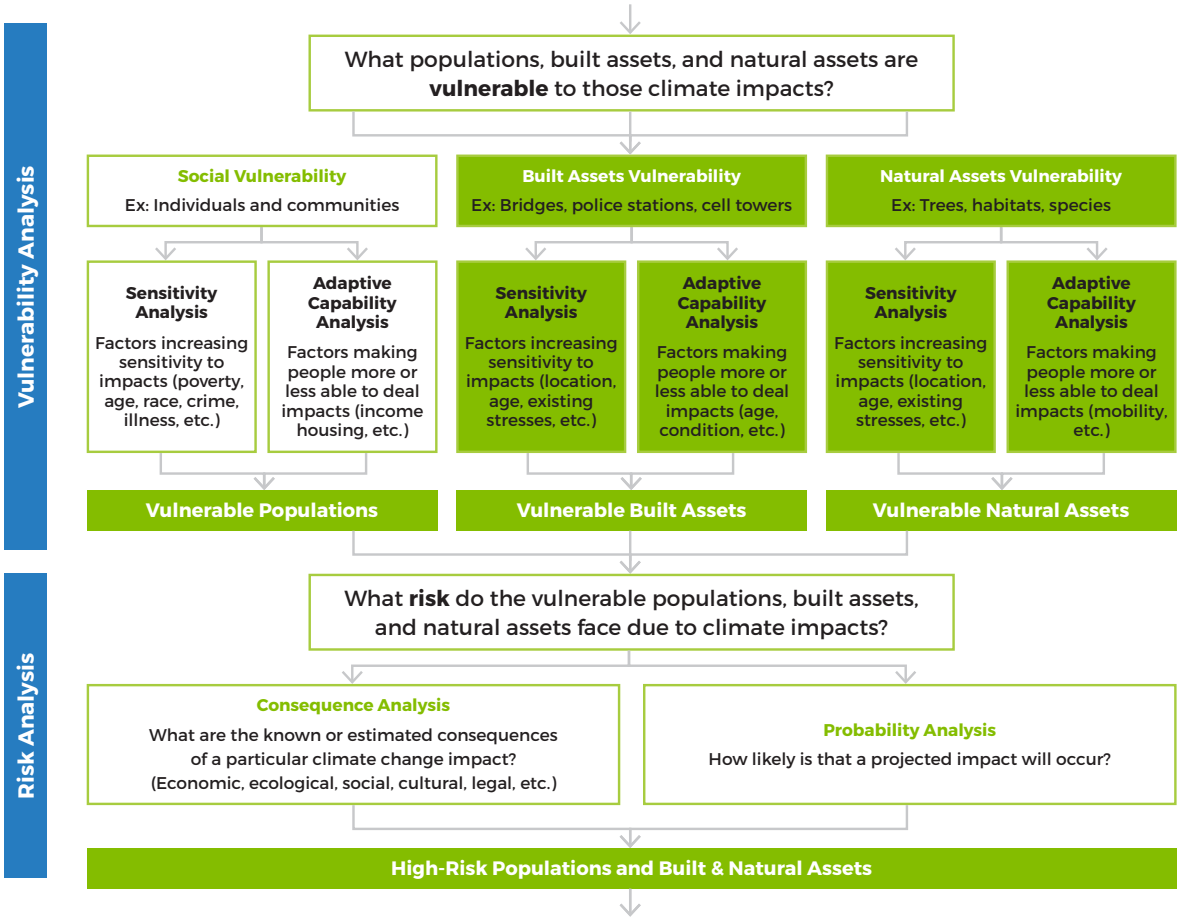
The final vulnerability score map was created using the results of the standard deviation scoring methodology, to compare relative overall vulnerability across Richmond's census tracts. This map shows the areas with the most social vulnerability in the darkest color, while lighter shades indicate lower levels of vulnerability. In subsequent sections, social vulnerability will be overlaid with the vulnerability ratings of built and natural assets to show the connections between people and environment and to inform prioritization of climate vulnerabilities. For example, the map below shows that some of the more vulnerable areas are adjacent to the river, which are also areas that will be at greater risk from flooding and sea level rise.



Source: City of Richmond, Climate Equity Index

5. Built and Natural Assets Vulnerability and Risk

This section addresses the vulnerability and risk analyses for built and natural assets for key climate impacts. Information on social vulnerability is incorporated through mapping analysis in these steps to understand where and how people and assets are being affected, especially for Richmond's most vulnerable communities



5.1 Analysis Methodologies

5.1.1 Vulnerability Analysis Methodology

Vulnerability to climate change encompasses physical, ecological, and social aspects that stem from increased extreme weather events, rising temperatures, changing precipitation patterns, sea level rise, and other aspects of climate on which the environment and human systems depend. Vulnerability is typically defined as a function of climate impact, sensitivity, and adaptive capacity.

In addition to creating the RVAgreen 2050 Climate Equity Index to assess social vulnerability of the Richmond community (discussed in Section 4), the City also engaged the RVAgreen 2050 technical working groups to assess vulnerability across categories of the City's built and natural assets. The working groups scored each asset type for sensitivity and adaptive capacity and discussed details on the potential consequences and implications of impacts to each.

The scoring classifications used with the working groups are shown in Figure 5.1. If a system or asset has both a high sensitivity to a climate impact as well as a low adaptive capacity, it is considered highly vulnerable. Results of the vulnerability assessment scoring for sensitivity, Adaptive capacity, and overall vulnerability for heat and water threats for built and natural Assets are presented in Appendix C. Built and natural asset vulnerabilities to flooding and heat were also mapped in order to understand where assets may be most vulnerable and where there may be concentrations of vulnerable assets, as well as allowing for overlays of social vulnerability with these asset vulnerabilities to understand how these potential impacts and any concentrations of impacts may affect Richmond's frontline communities.

Sensitivity
Degree to which a system, asset, or population may be affected when exposed to climate impacts.

Adaptive Capacity
Ability of a system, asset, or population to adjust to potential damage, take advantage of opportunities, or respond to consequences.

Vulnerability Assessment Scoring		Adaptive Capacity Classification		
		High	Medium	Low
Sensitivity Classification	Low	1	2	3
	Medium	2	3	4
	High	3	4	5

Figure 5.1 Vulnerability Assessment Scoring Matrix (Source: City of Richmond)

5.1.2 Risk Analysis Methodology

In concert with assessing the vulnerability of Richmond's systems and assets, measures of risk were also assessed across the city's populations, built assets, and natural resources. Risk was considered as a measure of both consequence and probability.

Consequences were rated by technical working group members and City staff based on a scale of low, moderate, and high for Richmond's systems and assets across eight dimensions or criteria. The following table outlines the scoring criteria, which attempt to, at a high level, measure the repercussions or implications of a specific climate impact. Consequences were assessed across all criteria for all asset groups and compiled to create a final "consequence score" for each asset group. Results of the Consequence scoring for Built and Natural Assets are presented in Appendix D.

Built and natural asset exposure to flooding and heat were also mapped in order to better understand where assets may be most vulnerable to climate impacts and where there may be concentrations of these vulnerable assets, and where socially vulnerable areas may intersect with these asset vulnerabilities to understand how these potential impacts and any concentrations of impacts may affect Richmond's frontline communities.

Probability was measured by mapping built and natural assets and identifying which of them lie within Richmond's hotter areas and potential areas for flooding. This mapping helps to understand where assets currently experience climate impacts and where they may be likely to experience future or increasing climate impacts, as well as where they may be concentrations of assets with risk exposure.

Consequence: Measure of the magnitude of repercussions associated with system/asset failure in the event of a climate impact

Probability: Likelihood of an asset or system to be impacted by a particular climate change shock or stressor

Consequence Score	Area of Service Loss	Duration of Service Loss	Cost of Damage	Impacts of Public Safety Services	Impacts of Economic Activities	Impacts to Public Health	Impacts to Vulnerable Populations	Impacts to Natural Environment
3 – High	2 or more council districts	> 7 days	> $1M	High	High	High	High	High
2 - Medium	1 council district	1-7 days	$100k-$1M	Moderate	Moderate	Moderate	Moderate	Moderate
1 - Low	Neighborhood	< 1 day	< $100k	Low	Low	Low	Low	Low

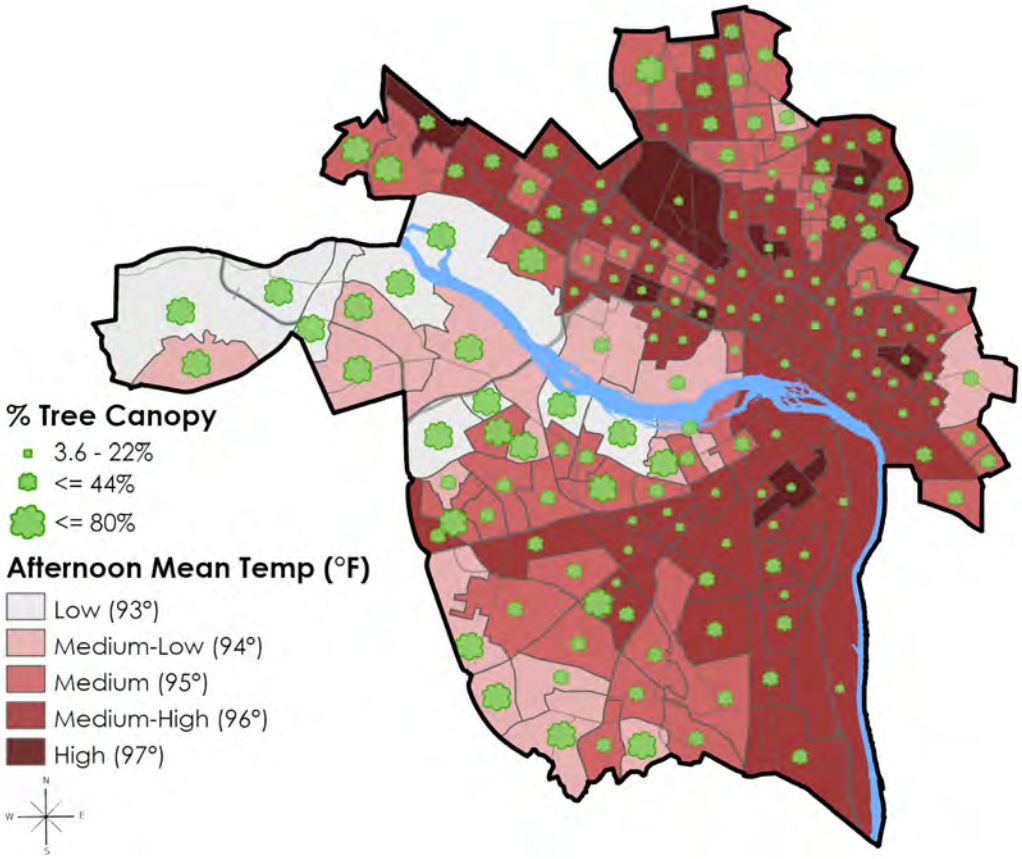
Figure 5.2 Consequence Scoring Matrix (Source: City of Richmond)

Much of Richmond's infrastructure will be resilient to future extreme heat events and increasing temperatures. The primary effects of future heat waves and increasing temperatures will be to the health and wellbeing of community members and natural resources. Increasing energy demand may impact power supply reliability, air quality, and utility costs, which will have the greatest impact on frontline communities.

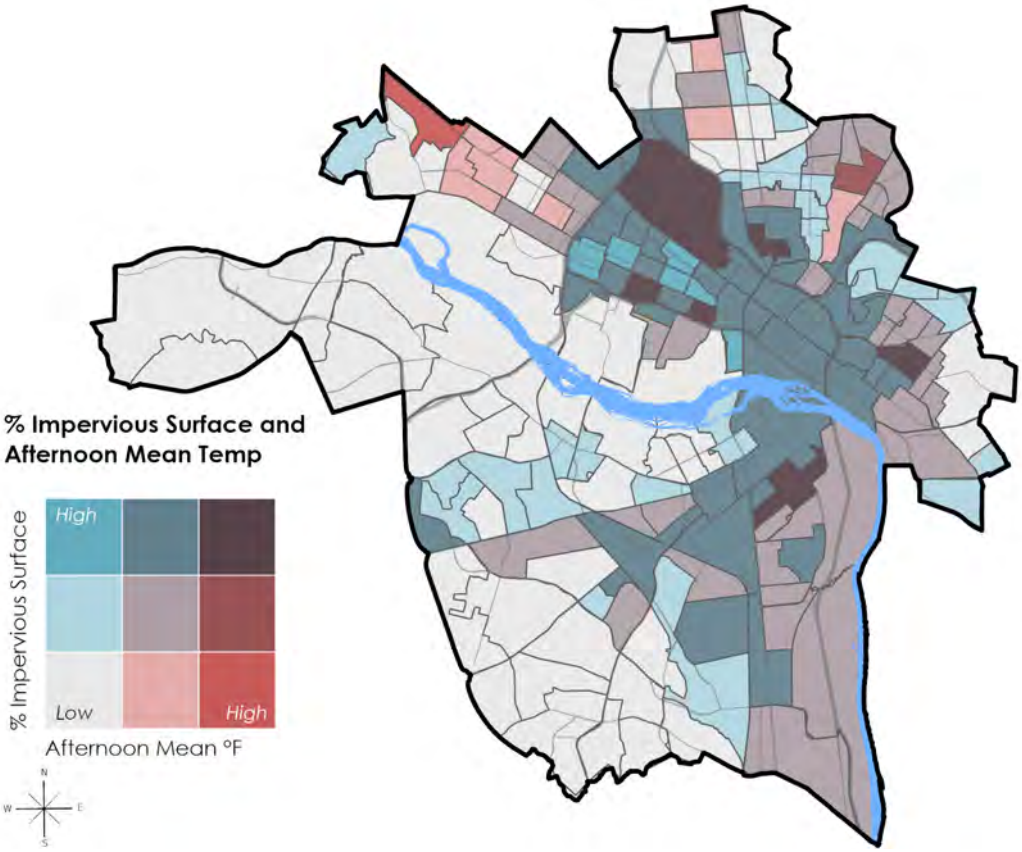
Richmond's Future Heat Risks

- Cooling demand / electric supply demand
- Power outages and supply drops (brownout)
- Urban Heat Islands
- Poor air quality
- Community health and public safety
- Limits to operating speed on rail lines
- Vegetation and native plant impacts, affecting runoff and combined sewer overflows

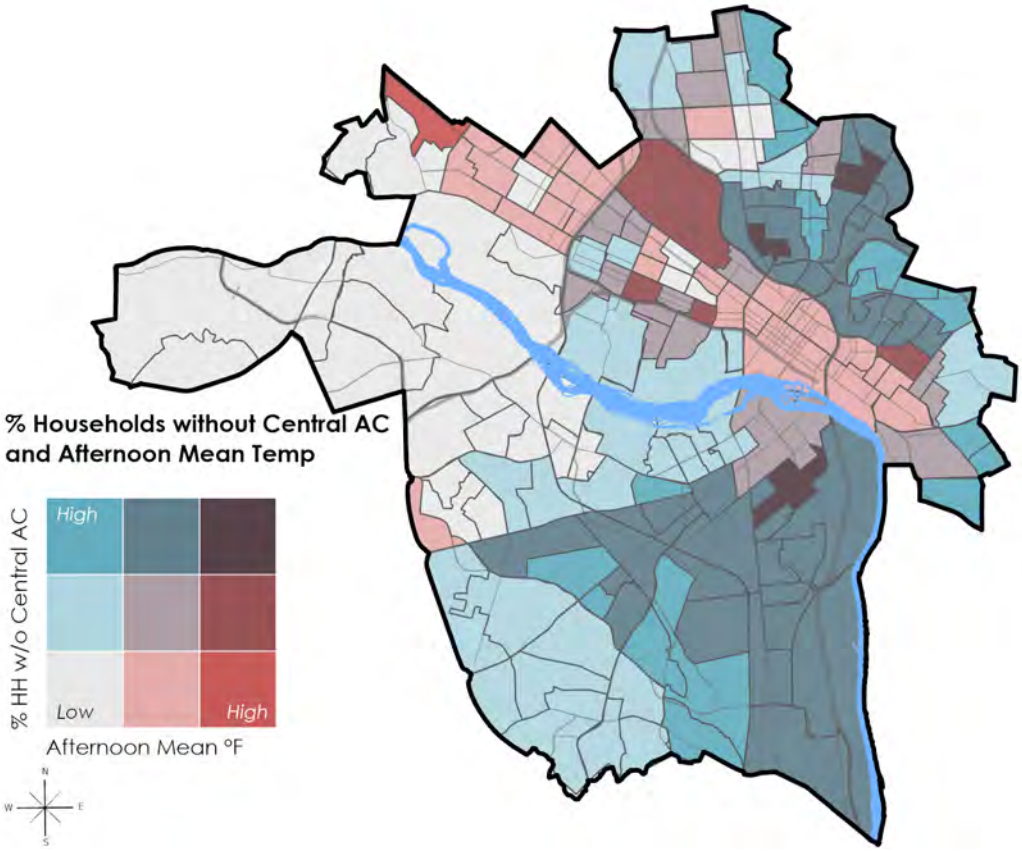
Heat Risk: Areas more at risk due to extreme heat and heat waves include those with higher temperatures shown below from the 2017 urban heat island study. Social factors - such as age, poverty, and race/ethnicity - also play an important role in evaluating overall risks to our community due to heat.



Source: City of Richmond, Esri, US Census Bureau



Source: City of Richmond, Esri, US Census Bureau



Source: City of Richmond, Esri, US Census Bureau

Approach to Assessing Flood Risk

The identification of flooding risk incorporates both changes over time to the City's floodplain areas as they are anticipated to expand and determination of those areas that are subject to localized flooding, inundation, and standing water, and thus will experience greater impacts as climate change causes more frequent extreme precipitation events.

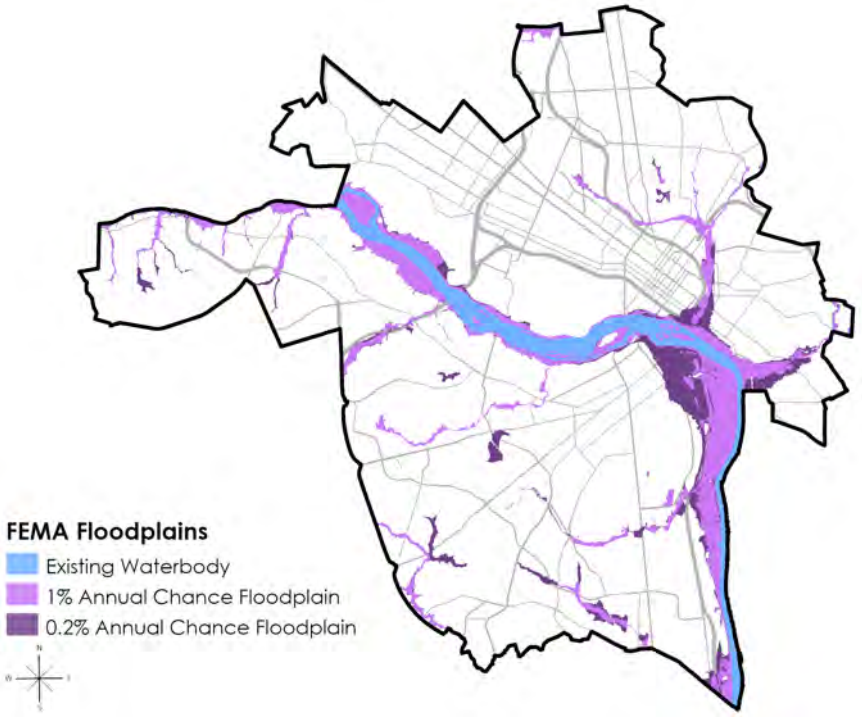
As discussed in Section 3, the FEMA floodplains for storms with a 1% annual chance of occurring were identified as the City's 2030/2050 planning scenario and represent future flood risk in this assessment with respect to floodplains. It is important to note that federal floodplain designations are currently based on historic data and do not take into account projections for increased flooding due to climate change. Following an example from Washington DC's climate vulnerability and risk assessment, the map uses the present 100-year (1-percent annual chance) and 500-year (0.2 percent annual chance) floodplains as determined by FEMA as a proxy for future flooding. This flood risk was augmented by detailed flood risk mapping that reflects Richmond's terrain.

ArcGIS-based flooding inundation model was applied to assess potential localized flood risks using detailed data on Richmond's terrain features and building locations to identify low-lying areas and depressions where water may collect during heavy precipitation and storm events. Depressions that would allow more than two inches of floodwater to collect and deeper areas that would allow flooding of more than five inches were both mapped. The analysis calculates the spillover from each depression to the next downstream depression to predict the overall consequences of stormwater.

Finally, the areas with inundation of more than five inches were added to the 2030/2050 floodplain scenario to define the critical flood risk for Richmond for this assessment.

Flooding Risk: Areas at higher risk for future flooding or inundation, either located in the 100-year floodplain or in areas where water may pool more deeply after storms (5 inches or greater)

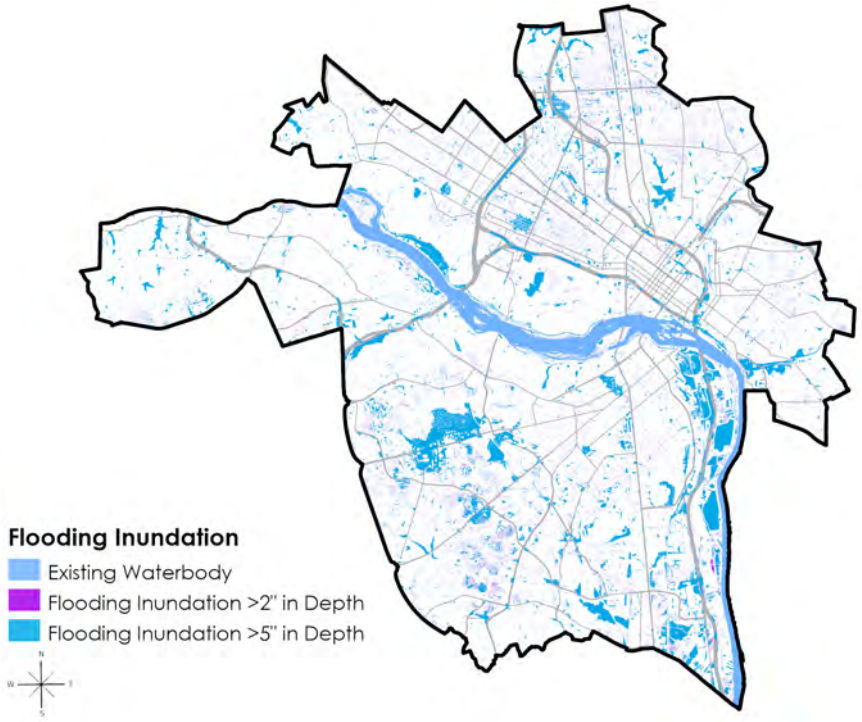
As storm and precipitation events continue to intensify, future flooding impacts will increase to communities, physical infrastructure, and natural resources throughout Richmond. Sea level rise will not impact as many areas of Richmond directly, but will impact natural, historic, energy, stormwater management, recreation, transportation, and other resources in and along the James River.



Source: City of Richmond, FEMA

Richmond's Future Flooding and Storm Risks

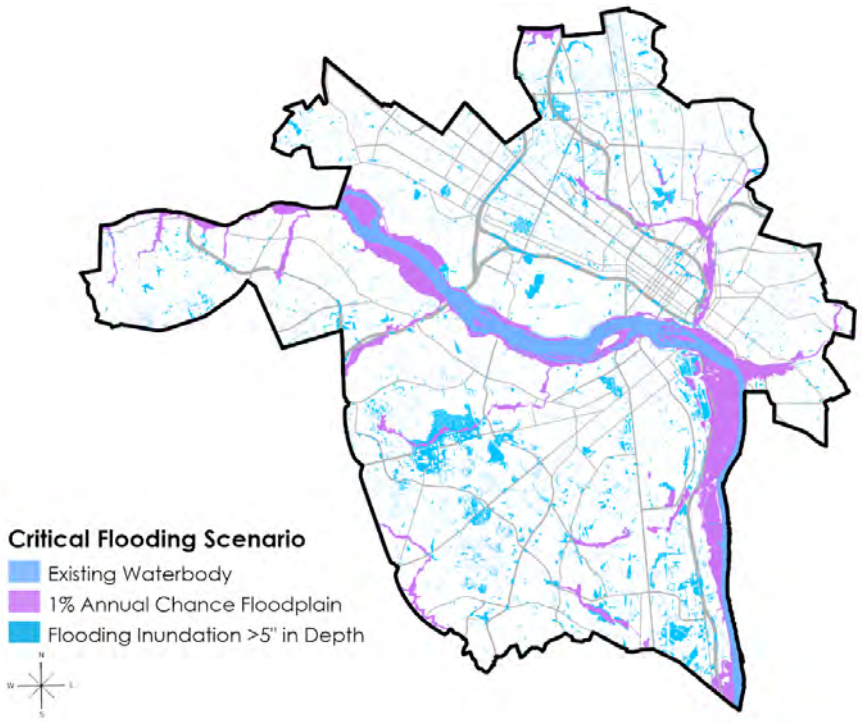
- Flood damage to properties, buildings, and equipment
- Flooding of area roadways Storm power outages
- Disruptions to public safety operations and emergency response
- Combined sewer system backups and wastewater overflow into local waters
- Sea level rise along the James River and tributaries Habitat impacts from permanent water level or quality changes



Source: City of Richmond, FEMA

5.2 Vulnerability and Risk Results

The figure below summarizes the results of RVAgreen 2050 technical working group scoring of Vulnerability and Consequence for Richmond's Built and Natural Assets. More detailed information on climate vulnerabilities, resilience factors, equity considerations, and assets at risk is presented along with the scoring results for each asset category in the sections that follow. For some asset categories Vulnerability and Consequence scoring ranged across the assets within the category and a range of scores rather than single score is indicated.

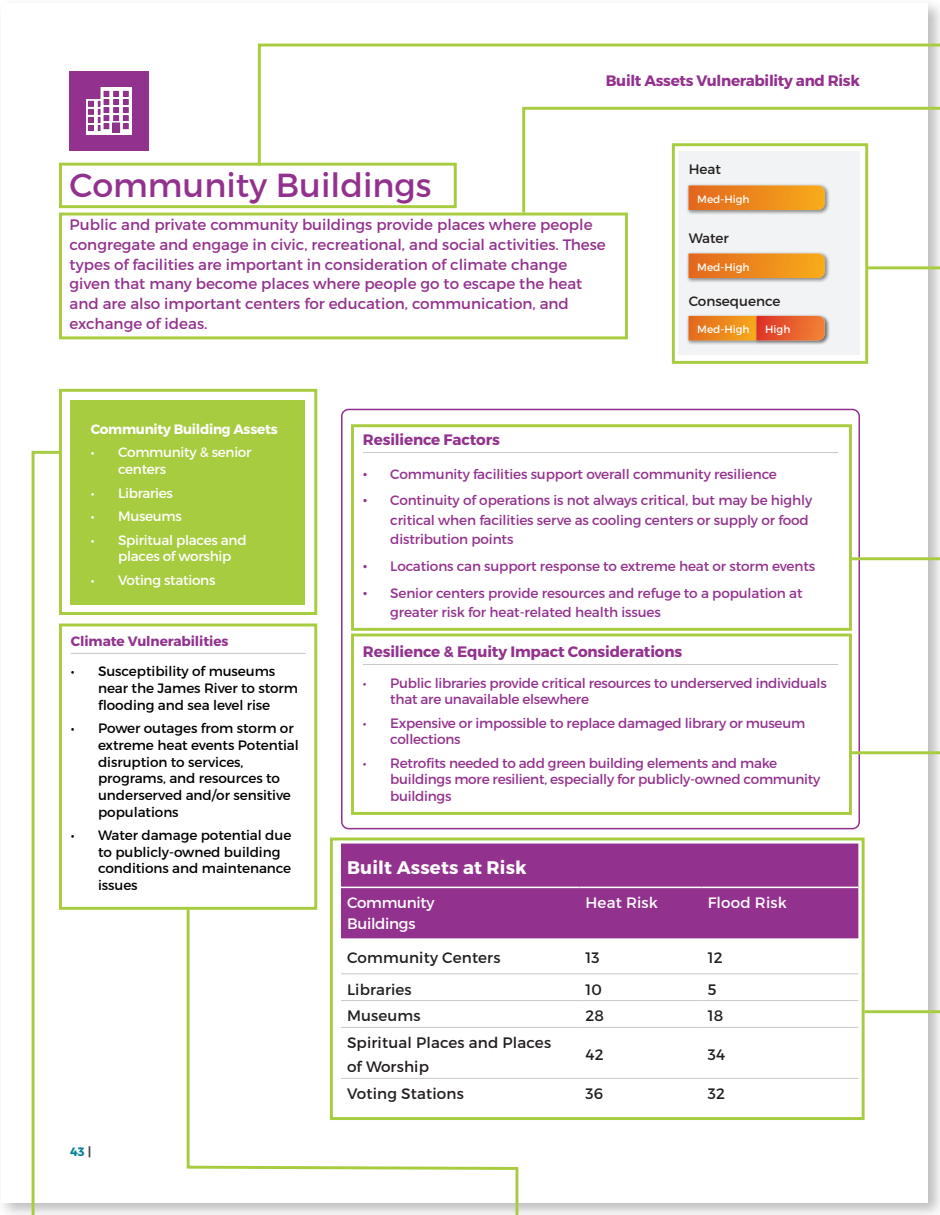


Source: City of Richmond, Esri, FEMA

Vulnerability and Consequence Scoring Summary

	Heat Risk	Flood Risk	Consequence
Communications Infrastructure	Medium	Medium	Medium
Community Buildings	Med-High	Med-High	Med-High / High
Education	Medium / High	Medium / Med-High	Medium / Med-High
Health and Social Services	Medium / Med-High	Med-High	Med-High
Historic	Med-High / High	Med-High / High	Medium / Med-High
Economic Development and Planning	Medium / Med-High	Med-High / High	Medium / Med-High
Energy Infrastructure	Med-Low / High	Low / High	Low / Med-High
Food System Assets and Resources	Med-High	Med-High	Med-High
Government Facilities	Med-High	Med-High	Med-High
Parks and Open Spaces	Med-High / High	Med-High / High	High
Public Housing Resources	High	High	High
Public Safety and Emergency Response	Medium / Med-High	Med-High	Med-High
Stormwater and Sewer Infrastructure	Medium	High	High
Waste Management Infrastructure	Medium	Med-High / High	Med-High / High
Water Supply Infrastructure	Medium / Med-High	Med-High / High	High
Transportation Infrastructure			
Roads and Bridges	Medium	Med-High	Med-High
Bike/Ped	Med-High	Med-High	Med-High
Rail and Transit	Medium	Med-High	Med-High
Marine	Med-Low	Med-High	Med-High
Airport	Med-High	Med-High	Med-High
Natural Assets			
Parks and Open Spaces	Med-High	Med-High	High
Terrestrial Habitat	Med-High	Med-High	High
Trees & Vegetation	Med-High	Med-High	High
Water Bodies	Med-High	Med-High	High

Guide to Vulnerability and Risk Asset Sheets



Asset Category

Asset Description

Describes assets in the category and/or their importance

Vulnerability and Consequence Scoring

Technical stakeholder group scoring (on a scale from low to high) of assets' vulnerability to heat and water threats and of consequences if assets are impacted

Resilience Factors

Identifies existing resources that currently contribute to climate and/or community resilience

Resilience & Equity Considerations

Issues noted by stakeholders, staff, or study team as potential resilience or equity concerns or issues to address for impacts to these assets

Assets at Risk

Number or amount (miles, acres) of each asset with exposure to potential heat risk and flood risk

Assets

Listing of assets considered in the asset category

Climate Vulnerabilities

The potential heat and flood impacts to assets in this category

Built Assets Vulnerability and Risk

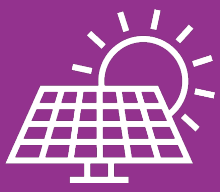
Built assets were identified by considering the people, resources, and infrastructure in the City of Richmond, as well as the services those resources and infrastructure provide. These include assets both internal and external to the City's operational control.

Communications

Community Buildings

Economic & Planning

Education



Energy

Food

Government Facilities

Health & Social Services

Historic Resources

Public Housing

Public Safety & Emergency Response

Stormwater & Sewer

Transportation

Waste Management

Water Supply

Communications Infrastructure

Richmond's communications infrastructure is critical for the community's ability to communicate, and becomes particularly important during extreme weather events when people need to report or respond to power outages or health/safety emergencies.

Heat

Medium

Water

Medium

Consequence

Medium

Communications Assets

- Radio transmission towers
- Cellular towers
- Other transmission towers

Climate Vulnerabilities

- Temperature effects to communications infrastructure during power outages
- Damage to towers and lines of cable from extreme storms, high winds, ice, or heavy precipitation
- Flooding at communication or data centers
- Service disruption

Resilience Factors

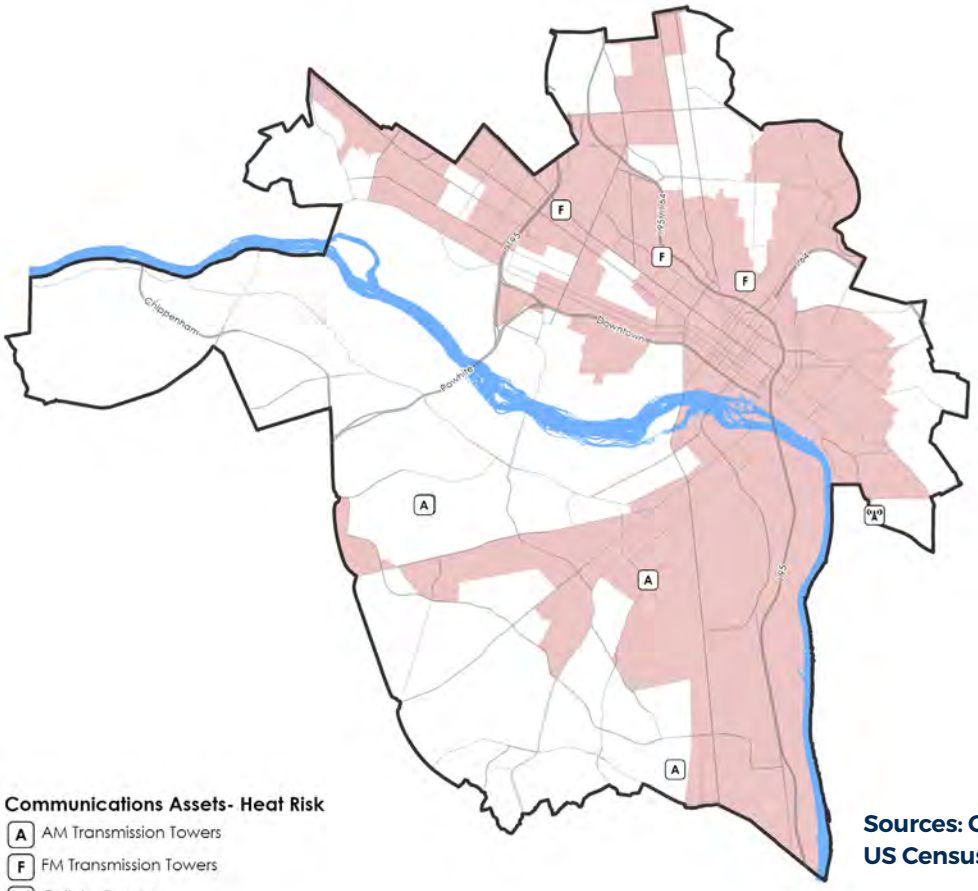
- Many emergency response and public safety facilities and operations have backup power supplies to ensure continuity of communications.

Resilience & Equity Impact Considerations

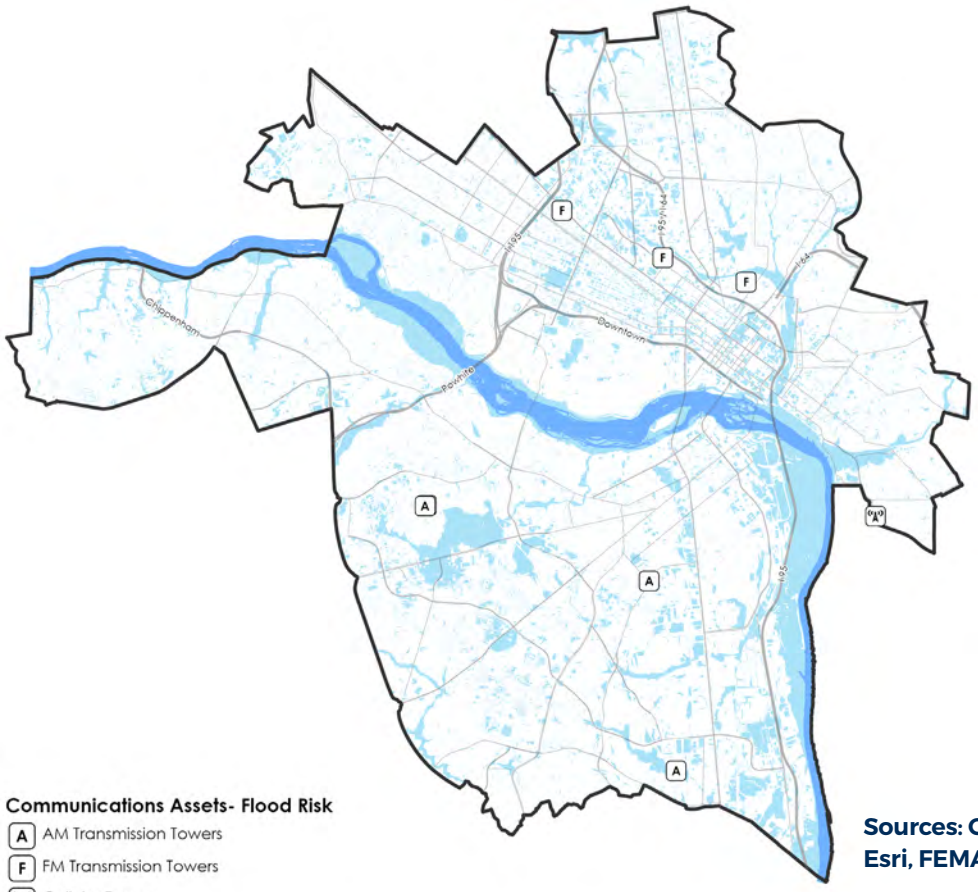
- Communications infrastructure service outages
- Cell service interruptions
- Public safety impacts
- Emergency response impacts

Built Assets at Risk

Communications Infrastructure	Heat Risk	Flood Risk
AM Transmission Towers	1	1
FM Transmission	4	0



Sources: City of Richmond, US Census Bureau



Sources: City of Richmond, Esri, FEMA

Community Buildings

Public and private community buildings provide places where people congregate and engage in civic, recreational, and social activities. These types of facilities are important in consideration of climate change given that many become places where people go to escape the heat and are also important centers for education, communication, and exchange of ideas.

Heat

Med-High

Water

Med-High

Consequence

Med-High High

Community Building Assets

- Community & senior centers
- Libraries
- Museums
- Spiritual places and places of worship
- Voting stations

Climate Vulnerabilities

- Susceptibility of museums near the James River to storm flooding and sea level rise
- Power outages from storm or extreme heat events Potential disruption to services, programs, and resources to underserved and/or sensitive populations
- Water damage potential due to publicly-owned building conditions and maintenance issues

Resilience Factors

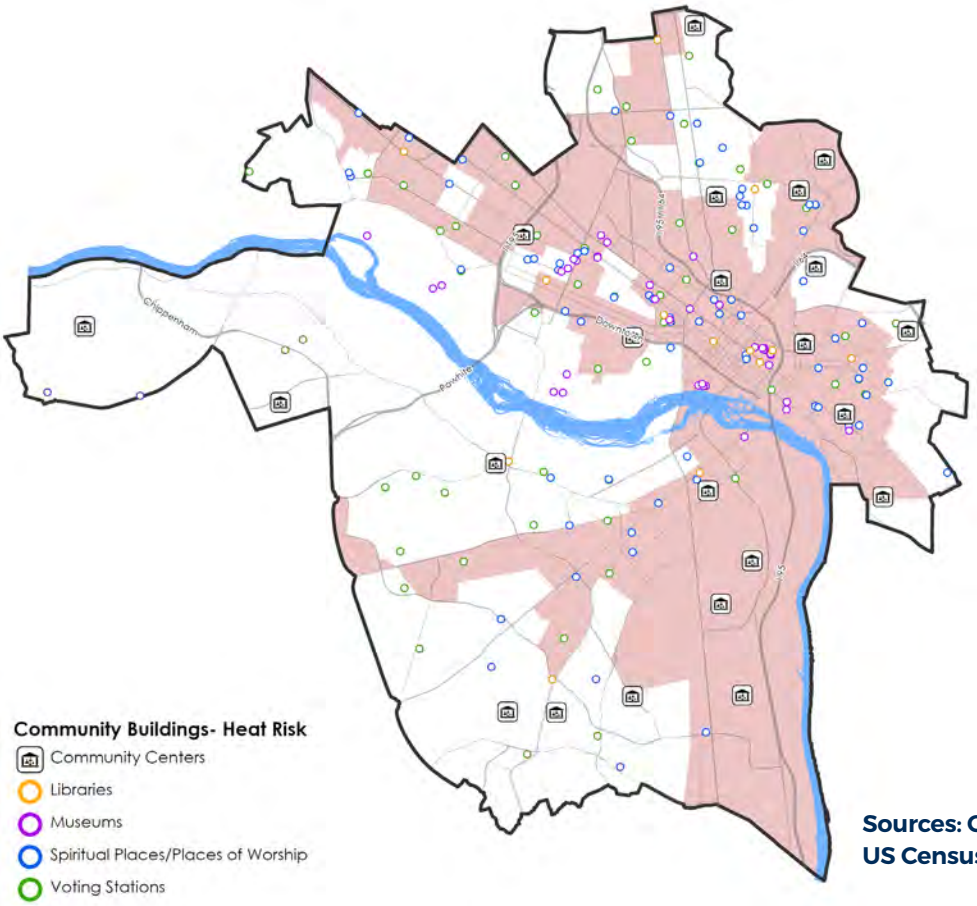
- Community facilities support overall community resilience
- Continuity of operations is not always critical, but may be highly critical when facilities serve as cooling centers or supply or food distribution points
- Locations can support response to extreme heat or storm events
- Senior centers provide resources and refuge to a population at greater risk for heat-related health issues

Resilience & Equity Impact Considerations

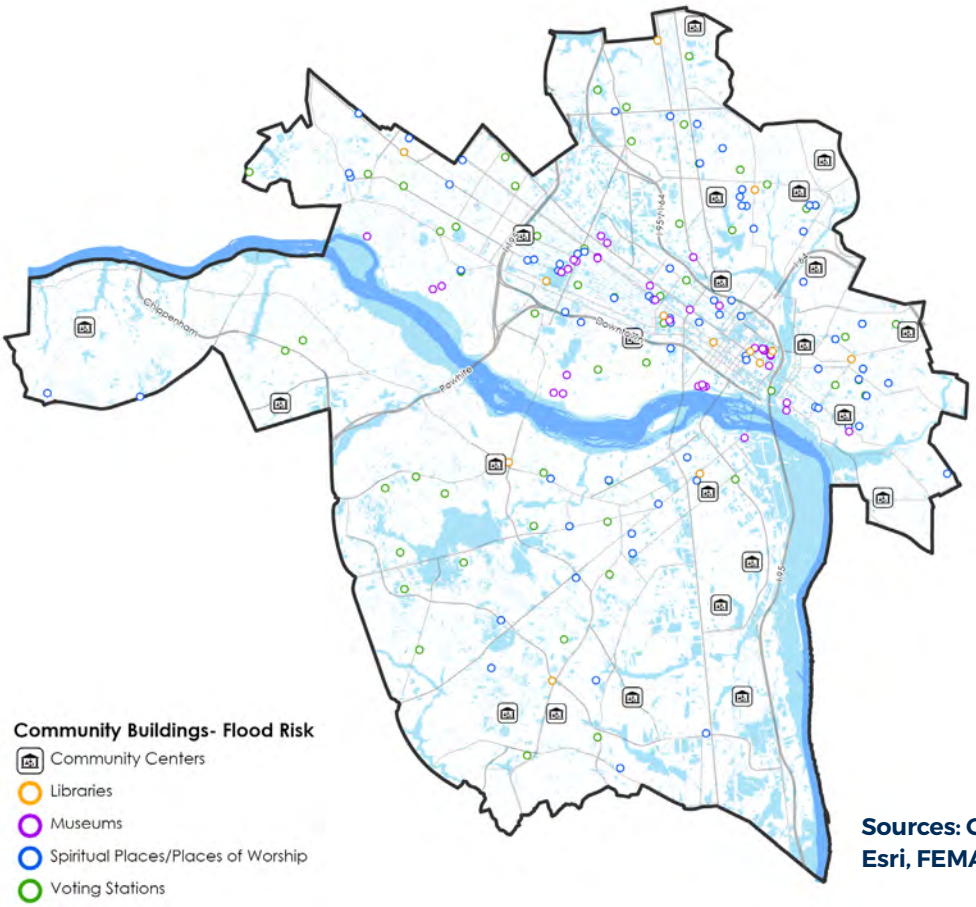
- Public libraries provide critical resources to underserved individuals that are unavailable elsewhere
- Expensive or impossible to replace damaged library or museum collections
- Retrofits needed to add green building elements and make buildings more resilient, especially for publicly-owned community buildings

Built Assets at Risk

Community Buildings	Heat Risk	Flood Risk
Community Centers	13	12
Libraries	10	5
Museums	28	18
Spiritual Places and Places of Worship	42	34
Voting Stations	36	32



Sources: City of Richmond, US Census Bureau



Sources: City of Richmond, Esri, FEMA

Economic Development & Planning

Richmond's centers of economic activity as well as those planned for increased economic development are critical to the city's economic well-being. These are sources of employment and income for many residents and business owners and provide important tax revenue to the city. Community members also rely on many businesses to provide goods and services.

Heat

Medium | Med-High

Water

Med-High | High

Consequence

Medium | Med-High

Economic development zones and districts

- Community unit and development plans
- Corporate headquarters
- Greater Richmond Convention Center

Climate Vulnerabilities

- Flooding, especially for small businesses
- Power outages from storm or extreme heat events
- Temporary and permanent business closures; according to FEMA, 25% of businesses do not reopen following a disaster, and many others will fail in the following year

Resilience Factors

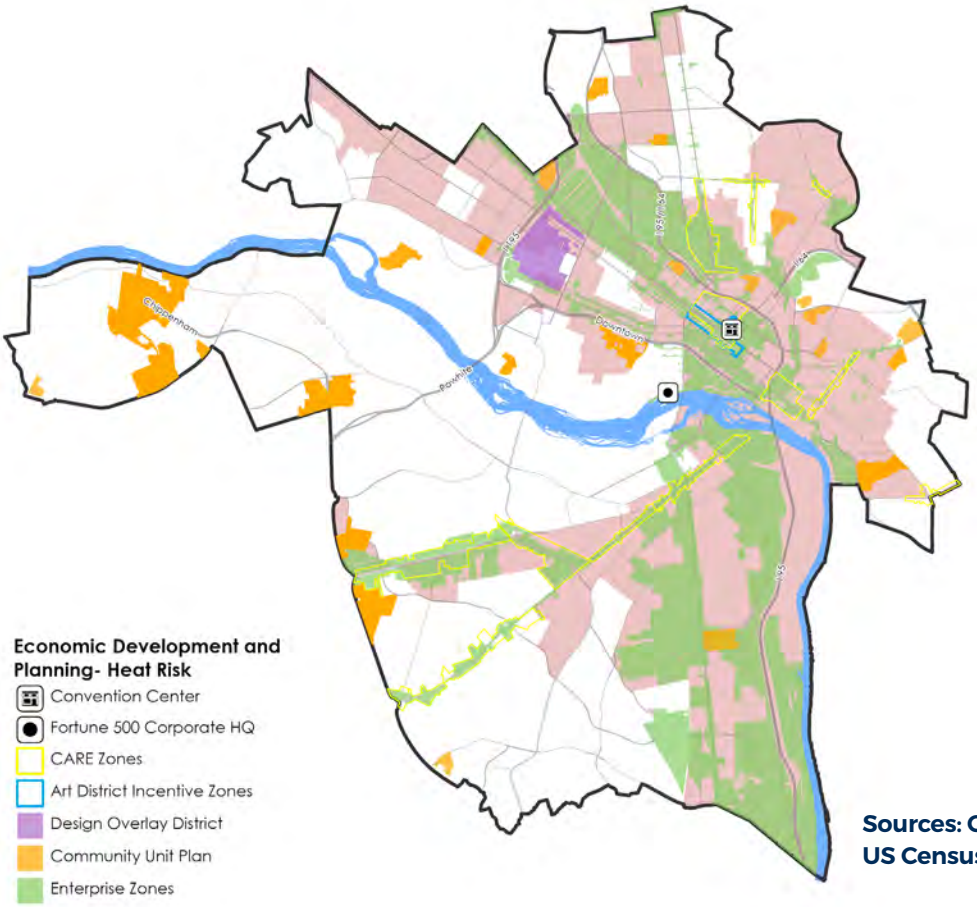
- Local, neighborhood businesses support overall community resilience and may provide support through resource distribution, coordination, or communication during or following extreme weather events and emergencies

Resilience & Equity Impact Considerations

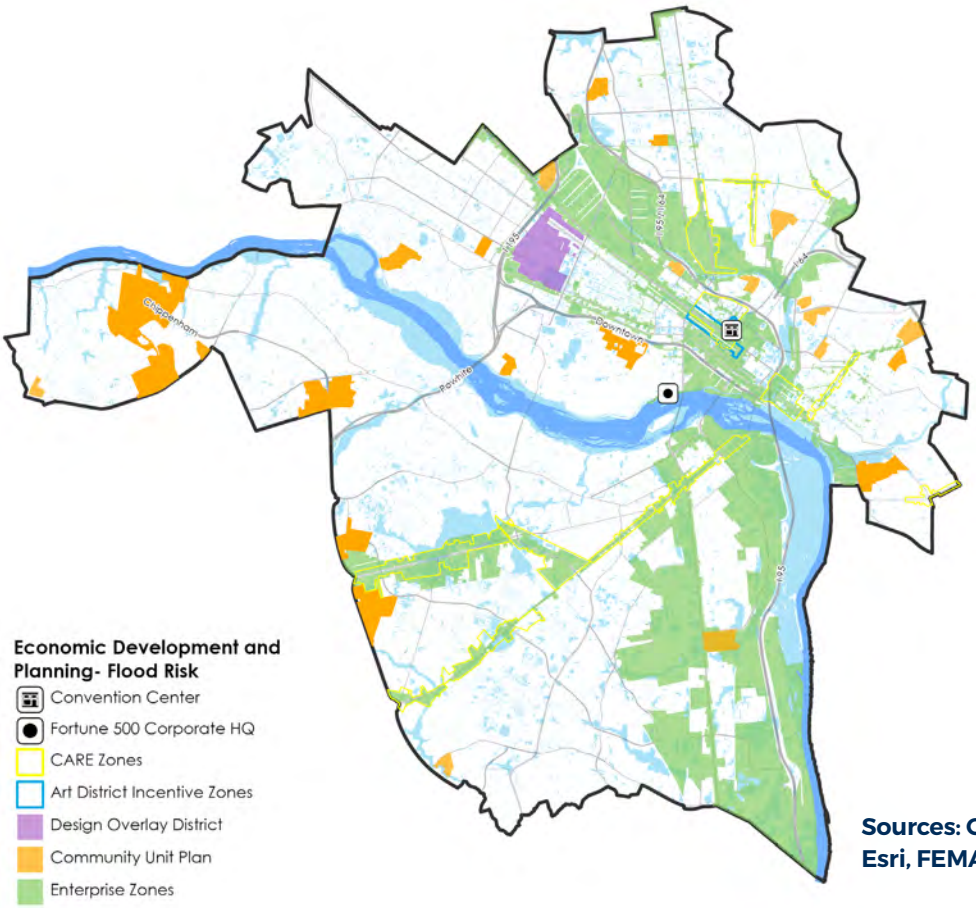
- Resilience may vary across individual businesses, economic areas, and neighborhoods and resources available
- Include climate resilience language in financial incentives for development zones
- Opportunities to make City attractive and economically resilient for those displaced by climate migration from other areas

Built Assets at Risk

Economic Resources	Heat Risk	Flood Risk
CARE Zones	12	13
Convention Center	1	0
Enterprise Zones	4	4



Sources: City of Richmond, US Census Bureau



Sources: City of Richmond, Esri, FEMA

Education

Access to education is foundational for individuals to achieve their potential and is a critical element of community social infrastructure. Primary and secondary educational facilities serve youth, young children, and families through education and wellbeing support services. Richmond's local colleges and universities offer opportunities for youth and adult learning, and programs that serve the wider Richmond community.

Heat

Medium | High

Water

Medium | Med-High

Consequence

Medium | Med-High

Education Assets

- Colleges and universities
- Daycare
- K-12 public schools
- Private schools

Climate Vulnerabilities

- Storm flooding impacting roadway and sidewalk access to schools
- Power outages from storms or extreme heat events
- School closures/service loss following climate-related weather events
- Disruption to school-based programs (nutrition, outreach, support services)
- Property damage costs, especially for public schools
- Impacts to vulnerable populations including youth and frontline communities
- Private schools and higher education facilities that have residential operations may experience unique impacts during extreme weather events

Resilience Factors

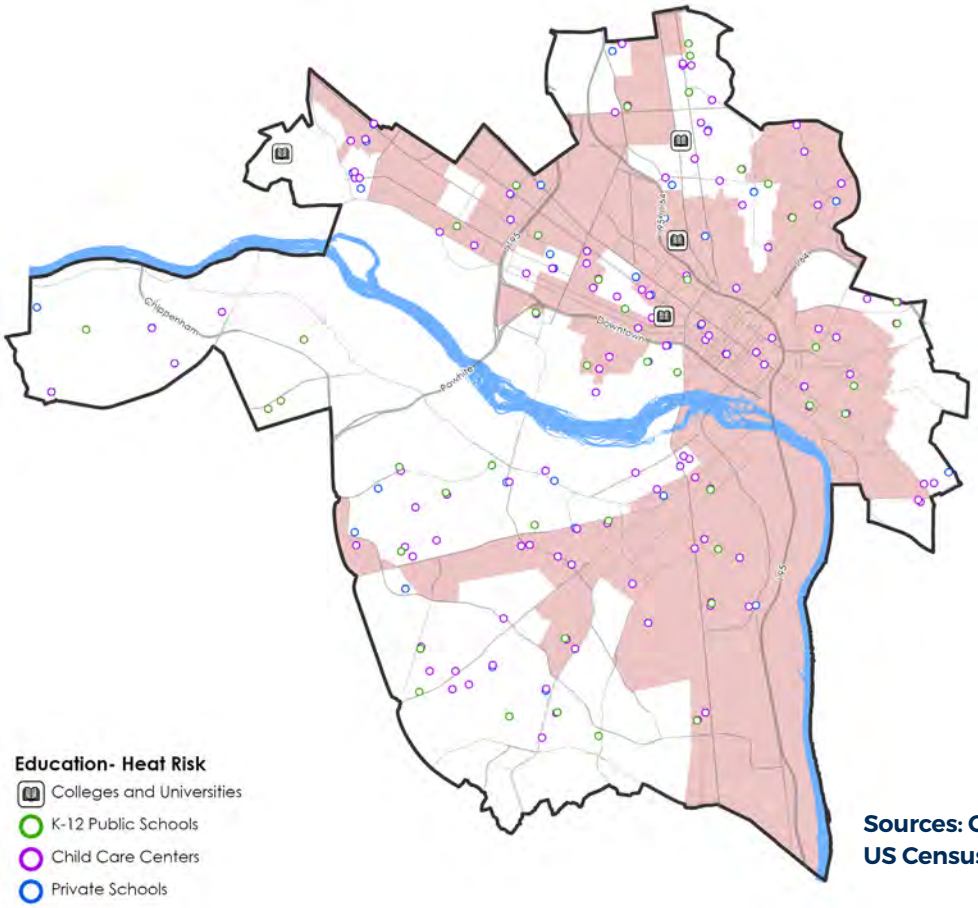
- Public schools serve as a key health resource for underserved youth through free and reduced lunch, breakfast, and other supplemental food services such as backpack buddies programs
- Schools are often key community hubs, forming a part of a community's response efforts during and following climate events or disasters
- Public schools can serve as cooling centers or shelters in extreme heat events

Resilience & Equity Impact Considerations

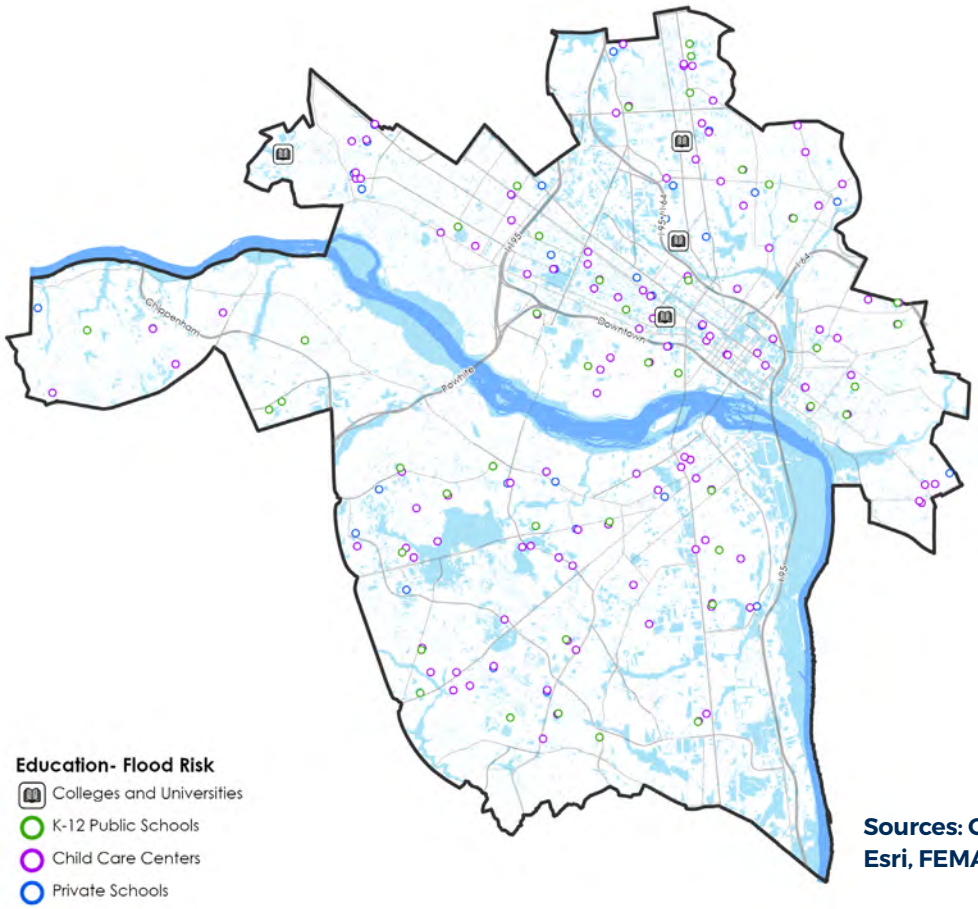
- Public school budgets and planning processes may limit adaptive responses
- Large universities serve as major community employers
- Higher education institutions offer resources such as residence halls, food preparation equipment, and safety personnel that could be leveraged for emergency response support
- University partnerships with agencies and non-profits are vital to climate action and response

Built Assets at Risk

Education Assets	Heat Risk	Flood Risk
Childcare Centers	61	43
K-12 Public schools	19	19
Private Schools	13	13
Colleges and Universities	2	4



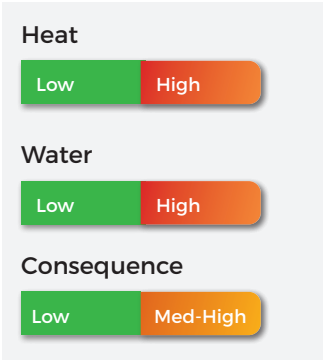
Sources: City of Richmond, US Census Bureau



Sources: City of Richmond, Esri, FEMA

Energy

Energy assets in Richmond include traditional and alternative energy sources. As the supply of clean, renewable energy continues to grow, this supports climate action by reducing GHGs and making Richmond's energy infrastructure more resilient. Continued growth and diversification of the energy portfolio, and efforts to assure integrity of the energy grid, will offer further community-wide economic, health, and other benefits.



Energy Assets

- Alternative fueling stations
- Biodiesel plants
- Electric transmission lines and substations
- EV charging stations
- Natural gas
- Petroleum ports and terminals
- Potential renewable energy Sites

Climate Vulnerabilities

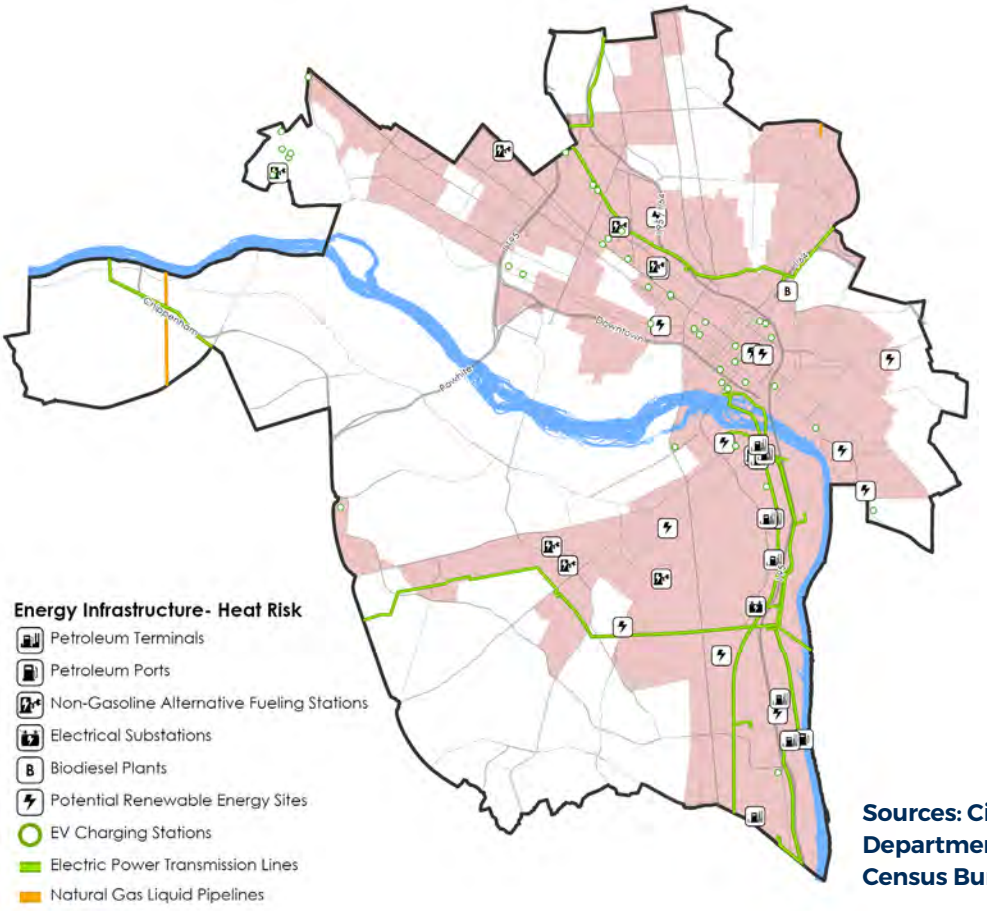
- Increased demands on the grid due to cooling needs
- Heat related sagging of power lines
- Reduced thermal efficiency of power generation due to extreme heat
- Thermal limits to the ability for transmission lines to transport power
- Storm damage to power lines
- Flooding damage to power plants, substations, and equipment
- Power outages

Resilience & Equity Impact Considerations

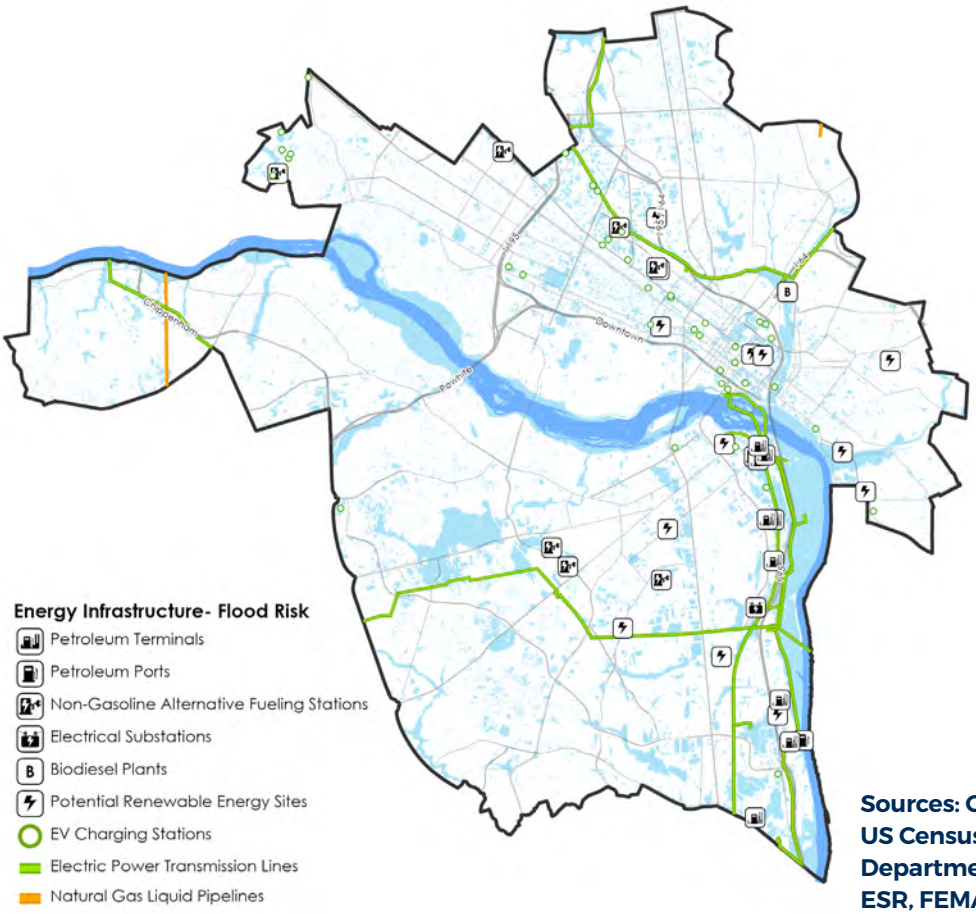
- The likelihood of flood damage is increased for facilities located in or near the floodplain
- Risks of leaks, hazardous material contamination, explosions, or chemical releases
- Grid transformation and security requires upgrades to make the grid more resilient

Built Assets at Risk

Energy	Heat Risk	Flood Risk
Biodiesel Plants	1	1
Electric Power Transmission Lines	45.2 miles	25.2 miles
EV Charging Stations	60	24
Petroleum Ports	1	1
Petroleum Terminals	9	8
Potential Renewable Energy Sites	12	3



Sources: City of Richmond, Department of Energy, US Census Bureau



Sources: City of Richmond, US Census Bureau, Department of Energy, ESR, FEMA

Food

Food systems are complex and include many different assets and resources at varying scales – from food production on farms and in urban agricultural settings, to food processing and distribution sites, grocery stores and food storage facilities, and the resources that help get food to Richmond's most vulnerable populations, such as food pantries and Supplemental Nutrition Assistance Program (SNAP) businesses.

Heat

Med-High

Water

Med-High

Consequence

Med-High

Food Assets

- Food pantries
- Public refrigerated warehouses
- SNAP businesses

Climate Vulnerabilities

- Changes to growing season duration
- Crop damage from periods of drought or extreme precipitation
- Extreme heat stressing livestock and farm workers
- Increased prevalence of new and/or more persistent forms of pests
- Soil erosion from floods
- Storm-related power outages affecting food distribution locations
- Impacts to food access due to transportation disruptions

Resilience Factors

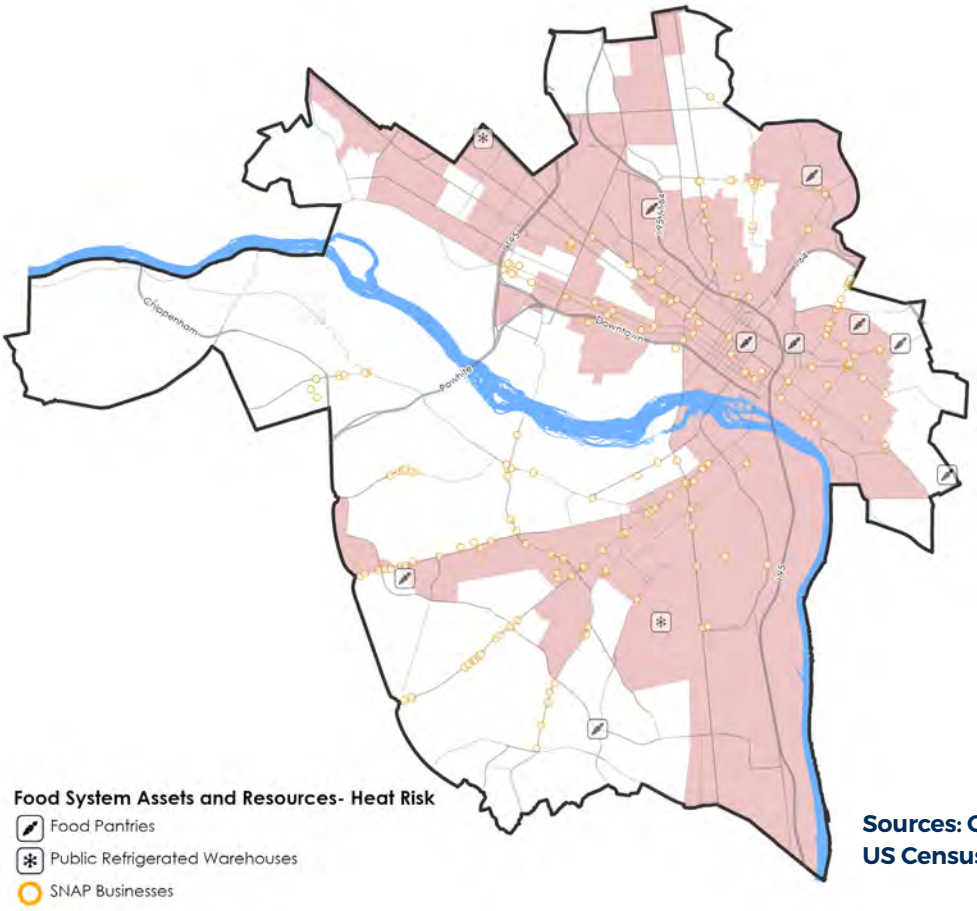
- Some community gardens are supporting community food system resilience

Resilience & Equity Impact Considerations

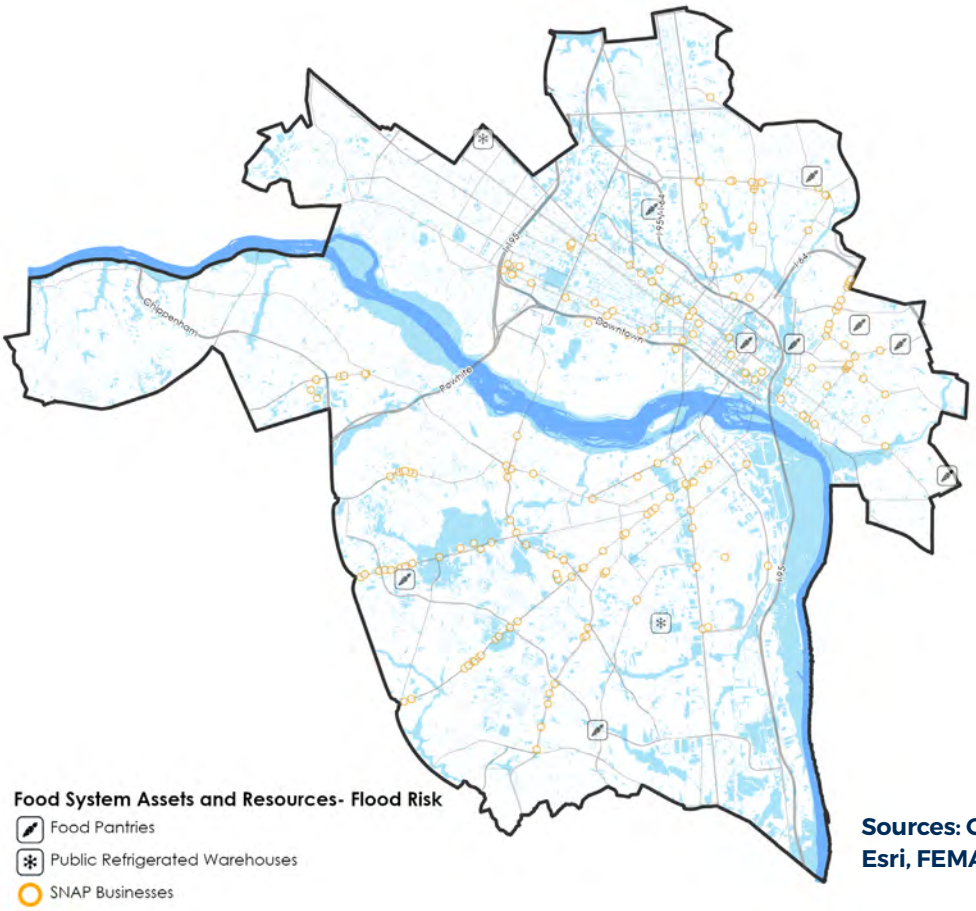
- Challenges to transporting food to people who need or getting people to where food supplies are if transportation is limited due to flooding
- Food pantries and storage facilities relying on power for refrigeration may be at risk when the grid is strained or during extreme weather events

Built Assets at Risk

Food System Assets and Resources	Heat Risk	Flood Risk
Food Pantries	5	0
Public Refrigerated Warehouses	2	0
SNAP Businesses	110	11



Sources: City of Richmond, US Census Bureau



Sources: City of Richmond, Esri, FEMA

Government Facilities

As the capital of Virginia, Richmond is home to numerous State buildings as well as City government buildings. While short-term impacts to government facilities may be overcome, residents rely on the work happening in these facilities to keep the city and the Commonwealth operating normally.

Heat

Med-High

Water

Med-High

Consequence

Med-High

Government Facility Assets

- City properties
- Courthouse and court systems
- Major state government buildings
- State capitol buildings

Climate Vulnerabilities

- Susceptibility of government buildings and properties near the James River or in other low-lying or flood prone areas to storm flooding and sea level rise
- Power outages from storm or extreme heat events
- Potential disruption of City or State services
- Water damage potential in older City or State buildings

Resilience Factors

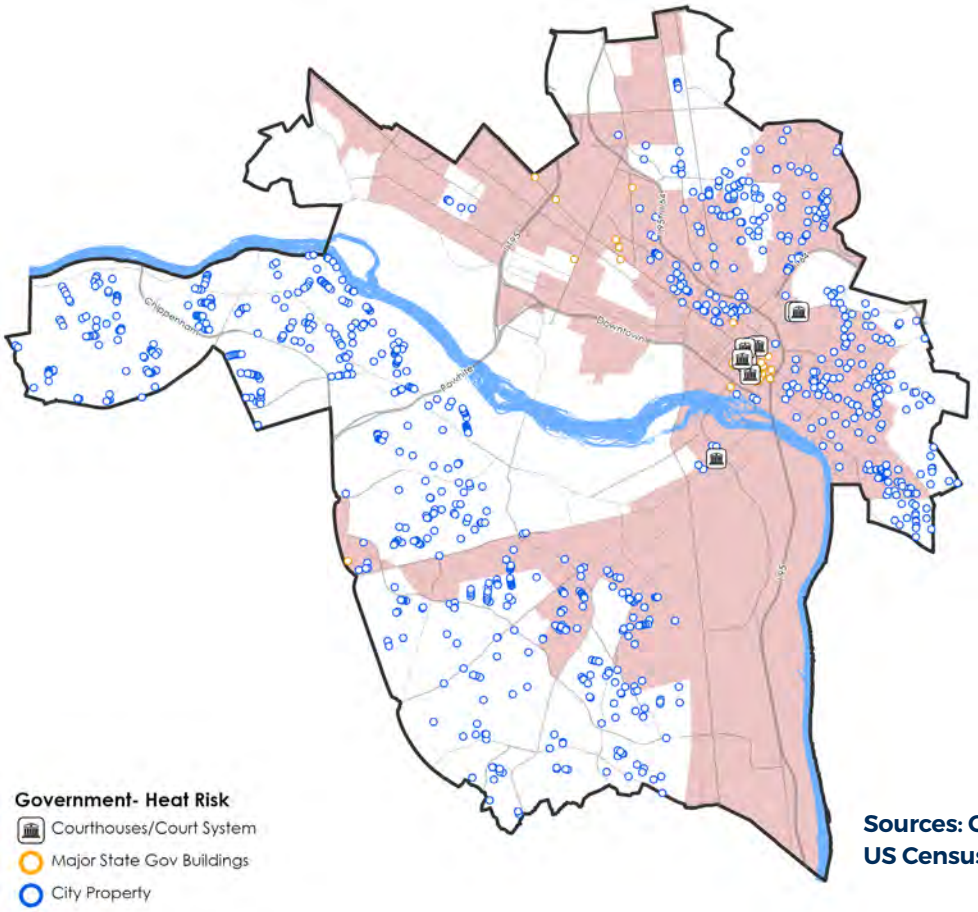
- Federal, state, and city agencies have established policies, procedures, and coordination plans in place for emergency response for disaster, storm, and other events
- City of Richmond has developed the Climate Equity Action Plan 2030 to address climate change through an equity-centered approach; this Vulnerability and Risk Assessment will expand on the plan's resilience strategies and prioritize action through an equity lens

Resilience & Equity Impact Considerations

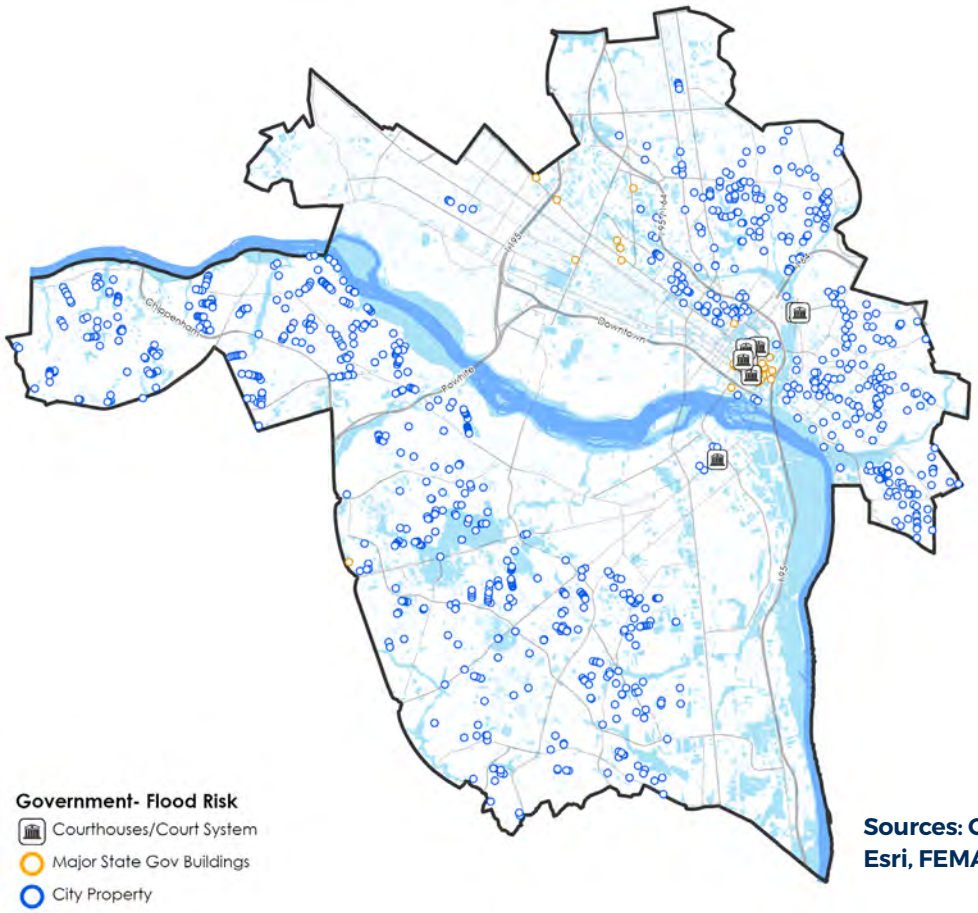
- City and State agencies and the buildings housing them are significant centers of employment
- Ensuring the safety of government employees, visitors, and continuity of operations is critical to Richmond's resilience

Built Assets at Risk

Government Facilities	Heat Risk	Flood Risk
City Property	369	118
Courthouses and Court Systems	9	1
Major State Government Buildings	36	18



Sources: City of Richmond, US Census Bureau



Sources: City of Richmond, Esri, FEMA

Health & Social Services

Health and social services facilities serve the most basic needs of Richmond's frontline communities, often on a daily or weekly basis. These are some of the most critical facilities that need to maintain continuity of their operations in order to serve some of our community's most vulnerable members, including seniors, low-income residents, and those with chronic or acute health issues.

Heat

Medium | Med-High

Water

Med-High

Consequence

Med-High

Health & Social Services Assets

- American Red Cross chapter facilities
- Dialysis clinics
- Homeless facilities
- Hospitals
- Nursing homes
- Social services
- Urgent care facilities
- VA health/medical facilities

Climate Vulnerabilities

- Power or even water outages from storm or extreme heat events
- Flooding of health and social services assets in low-lying areas or future floodplains
- Potential disruption to health services, programs, and resources to underserved and/or sensitive populations
- Loss of access to emergency services and care for frontline communities due to flooding
- Health impacts from extreme heat

Resilience Factors

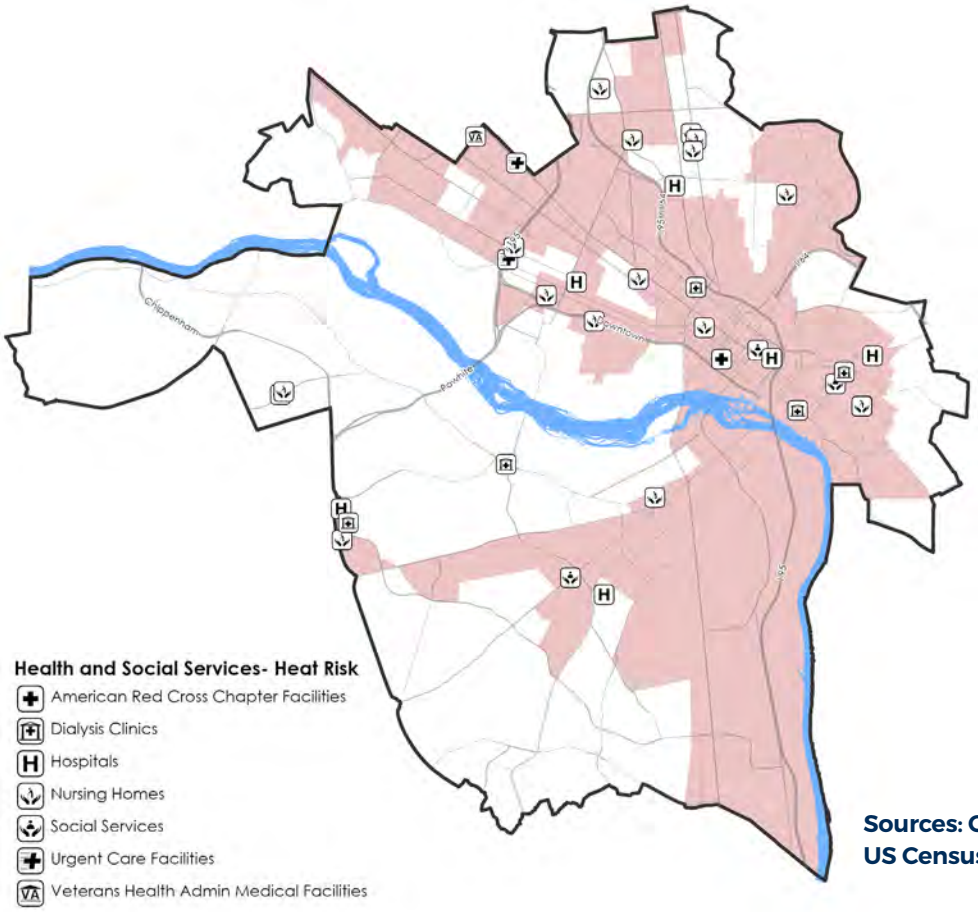
- Health and social services facilities support overall community resilience
- Larger hospital, nursing, and other facilities often have back-up power and system redundancy (e.g. for water lines)

Resilience & Equity Impact Considerations

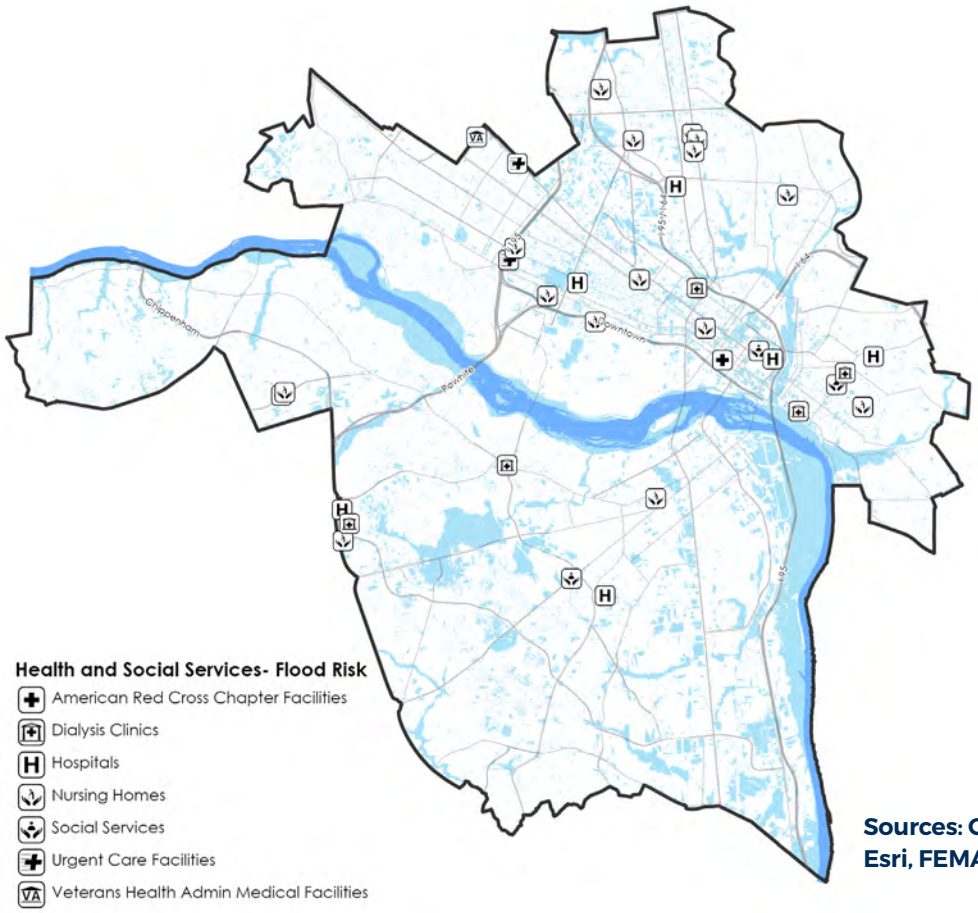
- Assess state of facilities in Richmond; ensure facilities have backup power sources
- Smaller facilities and clinics may not have sufficient adaptive resources
- The COVID-19 pandemic reinforced the need to look at consequences from multiple threats or stressors; Richmond has been seeing additional stress on its health assets; in the future these threats from events such as disease outbreaks would compound heat and water threats and diminish the adaptive capacity of health assets.

Highly Vulnerable Assets

Health and Social Service Facilities	Heat Risk	Flood Risk
Dialysis Clinics	3	0
Homeless Facilities	5	1
Nursing Homes	11	10
Social Services	3	1
Urgent Care Facilities	1	2
VA Health/Medical Facilities	1	0



Sources: City of Richmond, US Census Bureau



Sources: City of Richmond, Esri, FEMA

Historic Resources

A significant part of Richmond's character is tied to various historic assets that are maintained within the area. When impacted by a flood or storm event, sometimes damage to an historic asset may not be able to be repaired, or at least not while maintaining its historic character. Historic assets are not only culturally significant, they are also a source of economic activity for the city and the region.

Heat

Med-High | High

Water

Med-High | High

Consequence

Medium | Med-High

Historic Resources Assets

- City historic districts
- City historic sites
- National Register Historic Districts
- State and federal historic sites

Resilience & Equity Impact Considerations

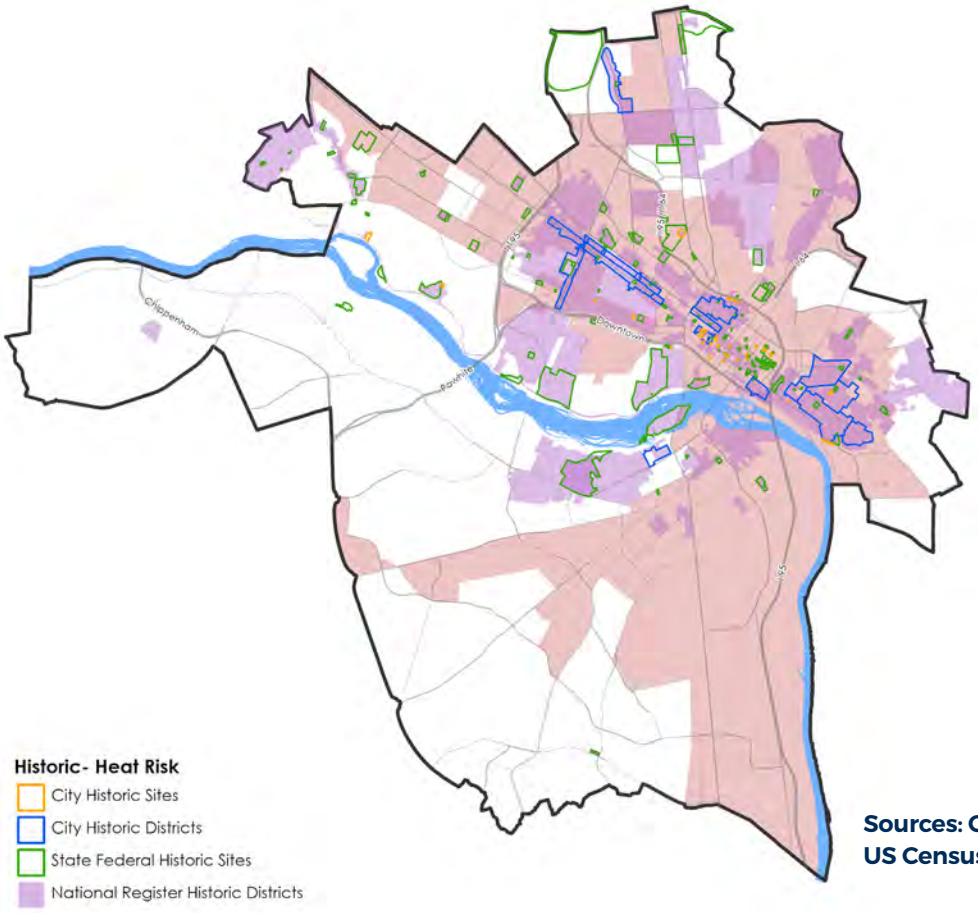
- Vulnerable to flooding damage due to age and condition of resources
- Possible retrofitting of structures to prevent lightning damages, increase heat resistance, and avoid flooding.
- Potential for engagement of cultural and historic resource organizations in climate action and resilience planning

Climate Vulnerabilities

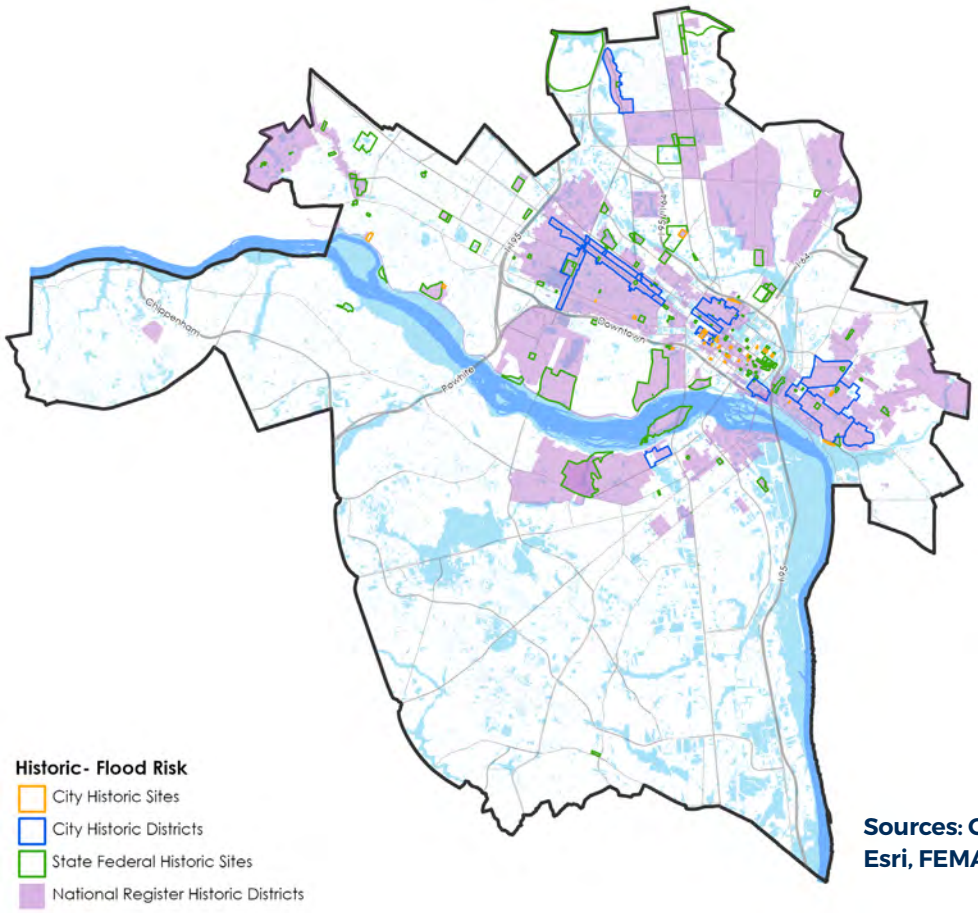
- Flooding damage from storms and extreme precipitation events
- Other storm impacts (lightning, wind, etc.)
- Possible interior damage during power outages due to heat and humidity levels
- Potential for irreparable impacts

Highly Vulnerable Assets

Historic Resources	Heat Risk	Flood Risk
City Historic Districts	41	41
City Historic Sites	26	25
National Register Historic Districts	108	122
State Federal Historic Sites	124	119



Sources: City of Richmond, US Census Bureau



Sources: City of Richmond, Esri, FEMA

Public Housing

Those living in public housing are among Richmond's most vulnerable populations. These communities often have lower average incomes, more limited resources, and experience more chronic stressors such as poor housing conditions, crime, and health conditions. Climate impacts intersect with existing social, health, and economic vulnerabilities for these residents.

Heat

High

Water

High

Consequence

High

Public Housing Assets

- Department of Housing and Urban Development (HUD)Multifamily Properties
- Richmond Redevelopment & Housing Authority (RRHA) Housing

Resilience & Equity Impact Considerations

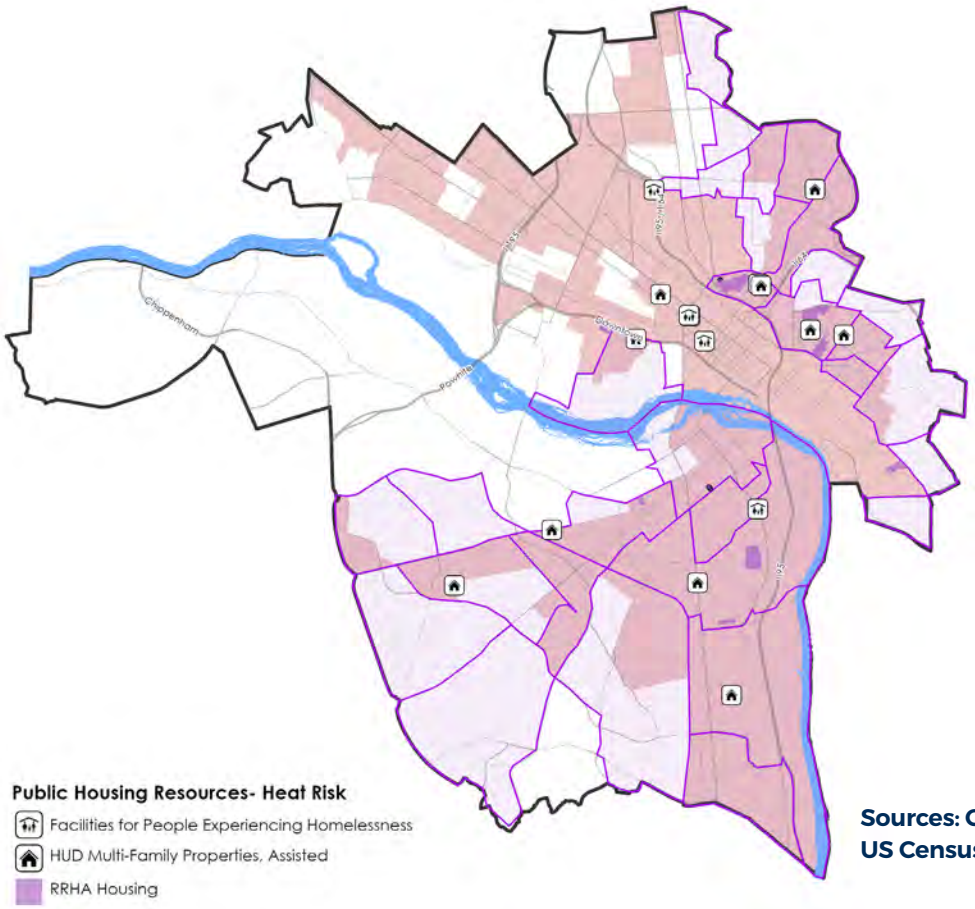
- Older housing properties have poor insulation and are more susceptible to extreme heat events, increasing utilities costs and potential health impacts for vulnerable residents
- Substantial retrofit and upgrade needs, which will require significant investment

Climate Vulnerabilities

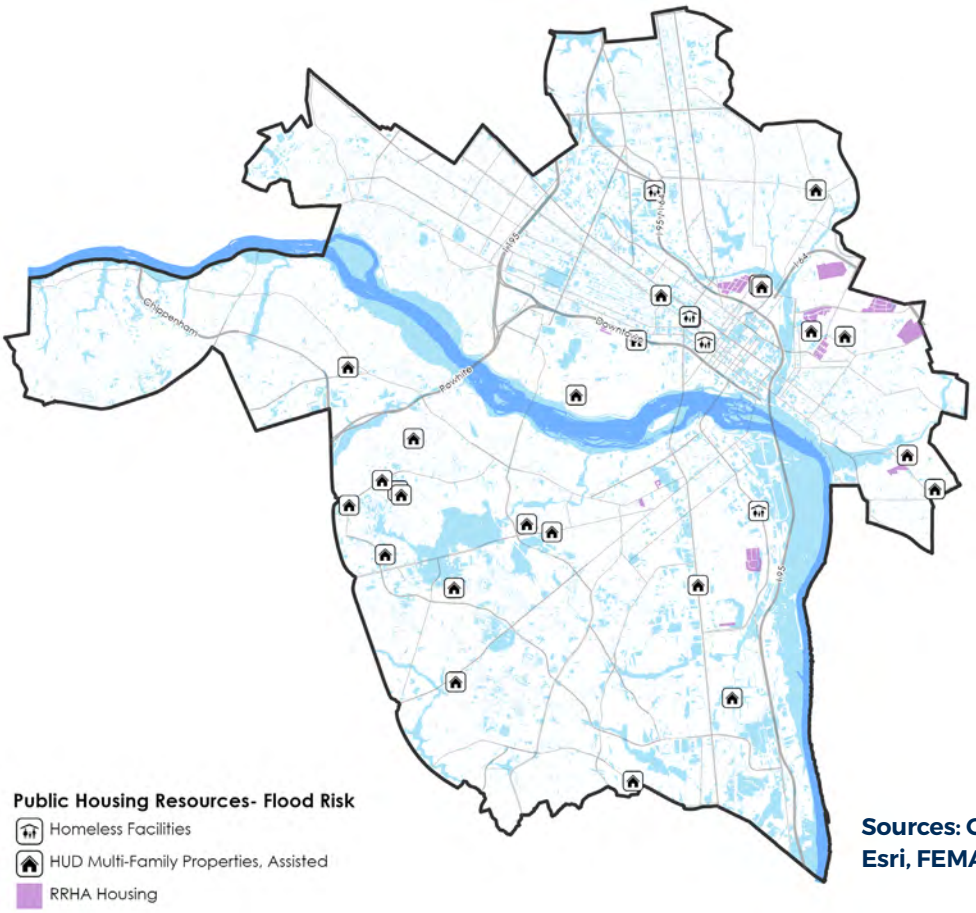
- Structural damage from flooding or extreme storms
- Development of mold and associated health risks following flooding
- Increased demand for cooling during extreme heat events
- Heat impacts resulting in increased energy burden and/or health effects
- Thermal stress on building materials over time increasing maintenance or reducing useful life
- Power outages from storm or extreme heat events

Built Assets at Risk

Public Housing Resources	Heat Risk	Flood Risk
HUD Multifamily Properties	13	2
RRHA Housing	36	42



Sources: City of Richmond, US Census Bureau



Sources: City of Richmond, Esri, FEMA

Public Safety and Emergency Response

Public safety facilities and emergency response operations are among the most critical assets within any community. Given the high level of importance of these facilities to public health and safety, the consequences are high if there are failures in the system.

Heat

Medium | Med-High

Water

Med-High

Consequence

Med-High

Public Safety and Emergency Response Assets

- Cooling centers
- Correctional facilities
- EMS, fire and police Stations
- Local emergency operations centers
- National shelter system facilities
- Seawall (data not available)
- Sheriff facilities

Climate Vulnerabilities

- Power outages from storm or extreme heat events
- Flooding affecting emergency response routes
- Potential disruption to public safety operations and response

Resilience Factors

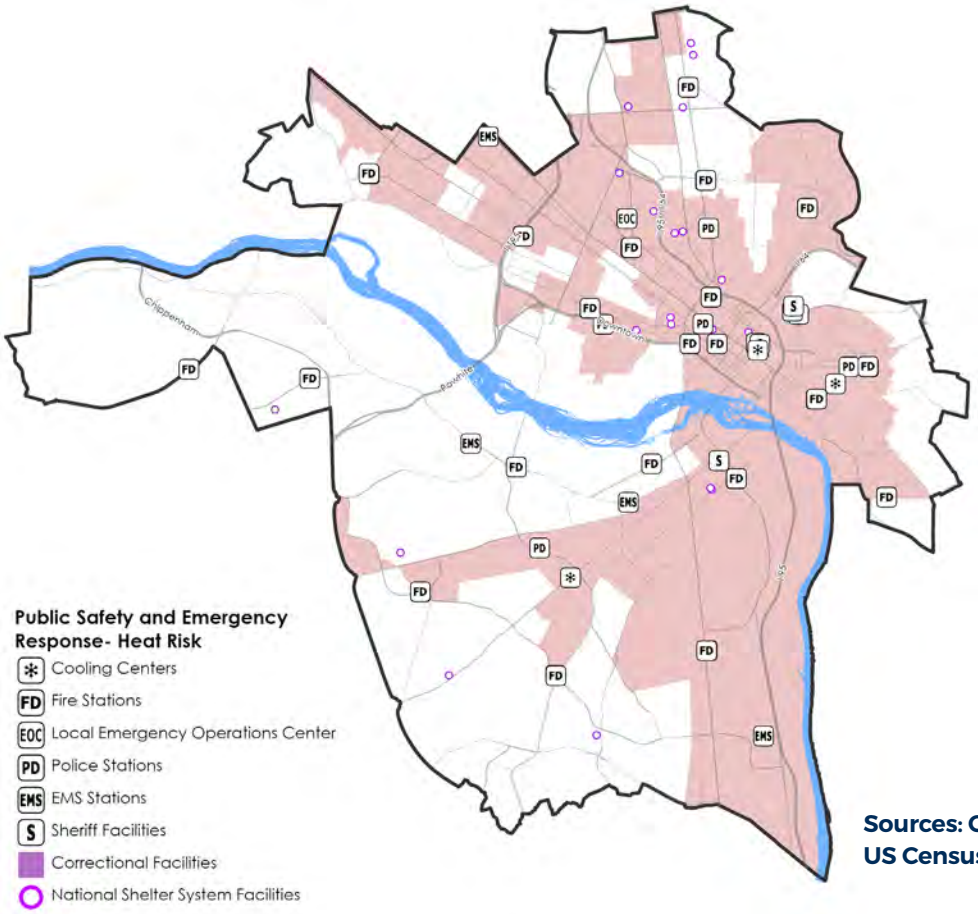
- Many emergency response and public safety facilities and operations have backup/redundant power supplies to ensure continuity of communications during emergencies
- Federal, state, and city agencies have established policies, procedures, and coordination plans in place for emergency response for disaster, storm, and other events
- The City's seawall provides flood protection and is regularly tested to ensure it is in good working condition.

Resilience & Equity Impact Considerations

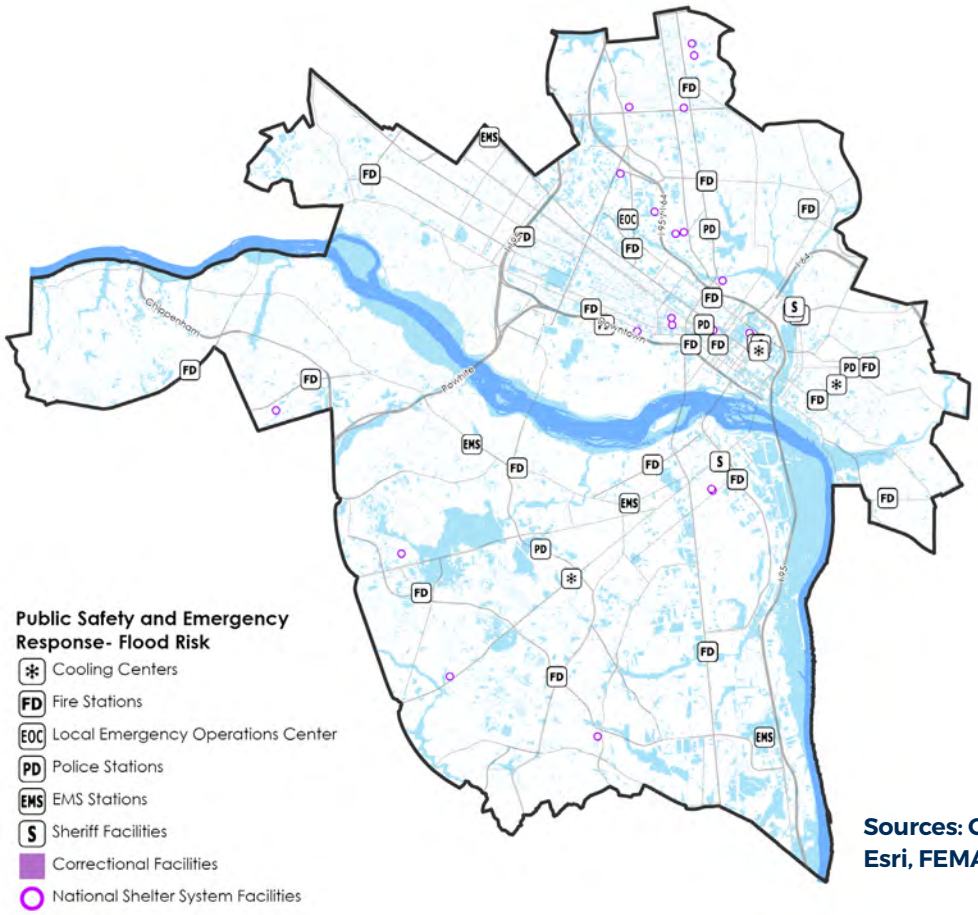
- In the past, public safety facilities and operations have been protected from heat and flood risks
- Emergency responders must be able to access areas that may be cut off during an extreme event
- Response plans need to address populations in correctional facilities during emergencies (e.g. during power outages, potential for situations requiring evacuation)

Built Assets at Risk

Public Safety and Emergency Response	Heat Risk	Flood Risk
Cooling Centers	3	1
Correctional Facilities	3	3
EMS Stations	16	11
Fire Stations	14	10
Local Emergency Operations	1	1
National Shelter System	13	11
Police Stations	5	1
Sheriff Facilities	7	5



Sources: City of Richmond, US Census Bureau



Sources: City of Richmond, Esri, FEMA

Stormwater & Sewer Infrastructure

Stormwater runoff is expected to increase through more frequent and more intense precipitation events. Richmond, like many older cities across the country, has an older stormwater system that was not built to handle today's storms or the storms of the future. In addition, a significant portion of the city's stormwater infrastructure is combined with sewer infrastructure, causing sewage overflows into the James River during extreme storms. Climate change will also stress Richmond's trees, vegetation, and greenspaces that help manage and absorb stormwater.

Heat

Medium

Water

High

Consequence

High

Stormwater and Sewer Infrastructure Assets

- Stormwater outfalls
- Stormwater & sewer Infrastructure (other)
- Sewer treatment plant

Climate Vulnerabilities

- Sea level rise inundation of stormwater outfalls near/along the James River
- Intense precipitation events causing sewer backups and wastewater overflow into local water bodies via the combined sewer system
- Flooding impacts to treatment plant and operations
- Heat impacts to the health of soils and vegetation (esp. urban and sensitive species) increasing rates at which water runs off of natural areas (overland flow) and decreasing the amount of stormwater that is naturally absorbed into the ground

Resilience Factors

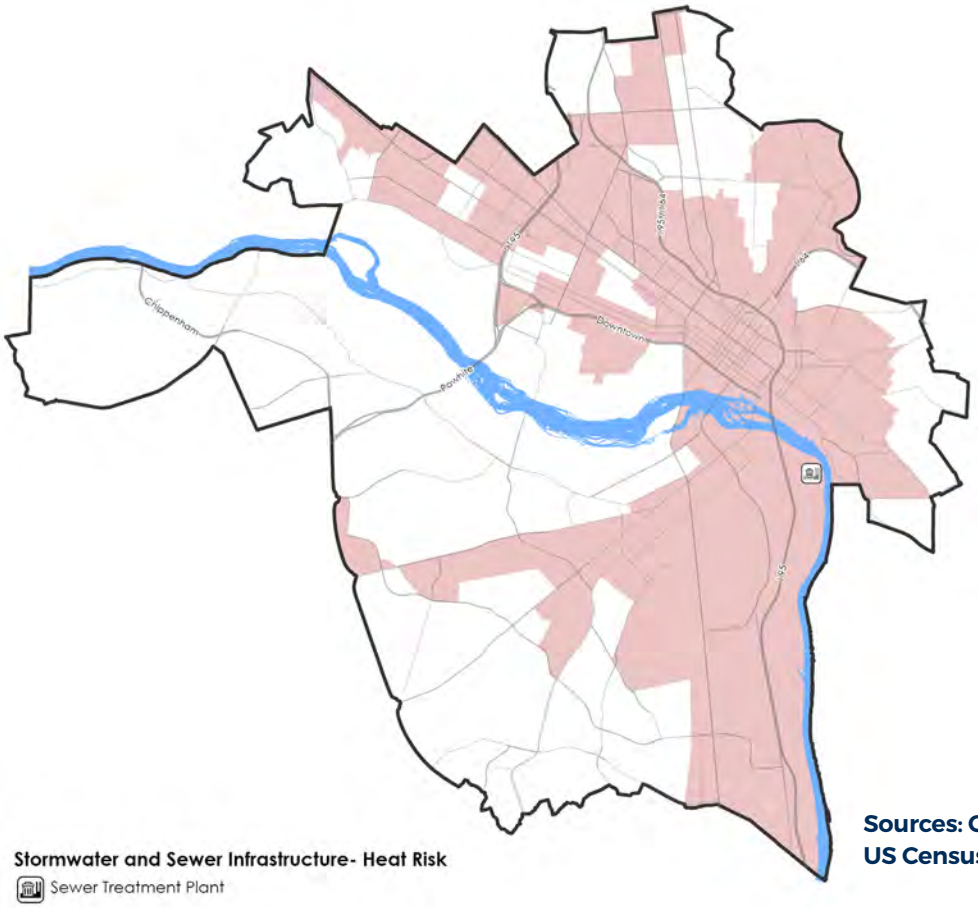
- The City is actively working to increase the capacity of the stormwater system and replace older infrastructure

Resilience & Equity Impact Considerations

- How to sustainably address need for increased watering to maintain heat-strained vegetation and enhance capacity to slow and absorb runoff
- Ensuring the wastewater treatment plant functions under greater threat and strain will require substantial investment
- As floodplains and flooding levels rise, buildings and equipment will need to be raised
- Stormwater facilities and features may need to be resized for future events
- Need to retrofit the combined sewer system

Built Assets at Risk

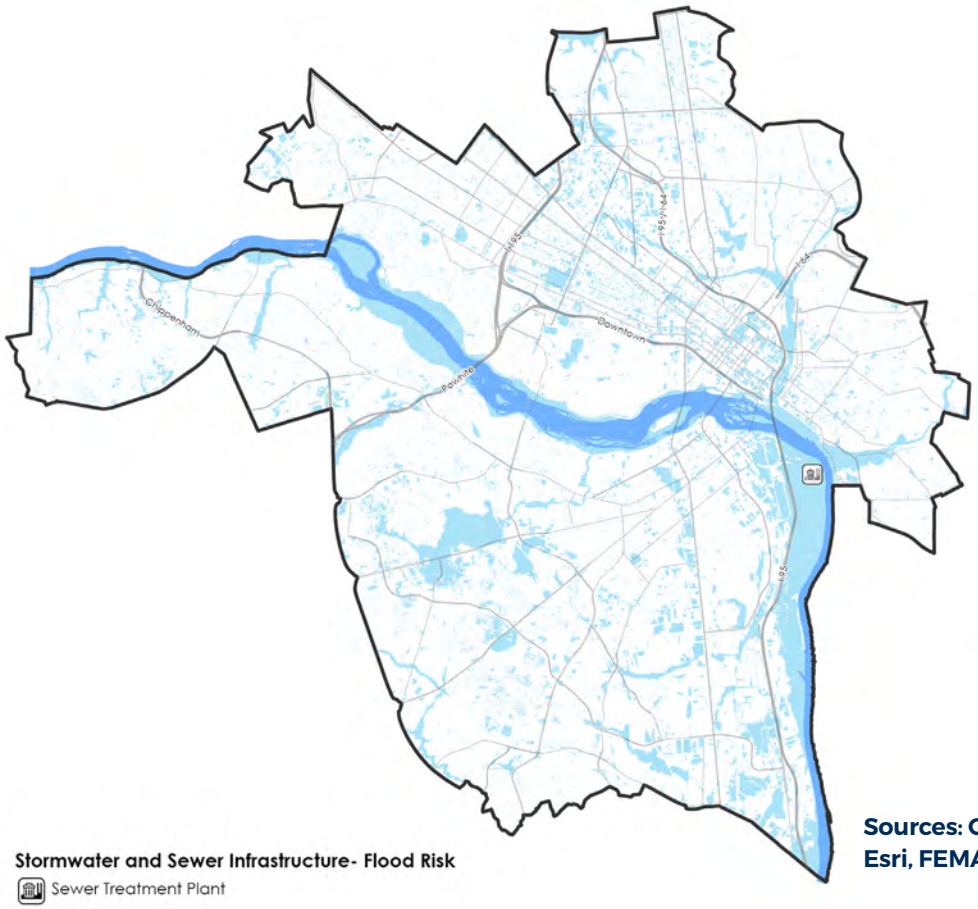
Stormwater and Sewer Infrastructure	Heat Risk	Flood Risk
Stormwater Outfall	468	1064
Sewer Treatment Plant	1	1



Stormwater and Sewer Infrastructure- Heat Risk

Sewer Treatment Plant

Sources: City of Richmond, US Census Bureau



Stormwater and Sewer Infrastructure- Flood Risk

Sewer Treatment Plant

Sources: City of Richmond, Esri, FEMA

Transportation: Roads & Bridges

Richmond's roadway network supports vehicular mobility for residents, workers, and visitors through 1,200 miles of roadways and 177 bridges. The City is bisected by two interstates (I-64 and I-95) and surrounded by I-295. Each of these facilities carries significant traffic, with Average Daily Traffic (ADT) ranging between 50,000 and over 100,000 vehicles daily, according to Virginia Department of Transportation (VDOT).

Heat

Medium

Water

Med-High

Consequence

Med-High

Transportation Assets

- Roads
- Bridges

Climate Vulnerabilities

- Flooding on roadways and bridges, washing out sections of road, or undercutting roadbeds
- Increased stormwater runoff
- Storms causing downed trees or powerlines blocking roadways
- Difficulty accessing areas of the community due to roadway blockages and signal outages
- Emergency response impacts
- Extreme heat impacts damaging roadway and bridge asphalt and concrete surfaces
- Increased surface temperatures, ambient heating of the surrounding environment, and contribution to urban heat islands

Resilience Factors

- Emergency response plans and coordination agreements are in place between State and local agencies for response
- Efforts by the Richmond Regional Transportation Planning Organization (Plan RVA) are developing road/bridge resiliency mapping that is assessing available alternative routes to more regularly inundated roadways

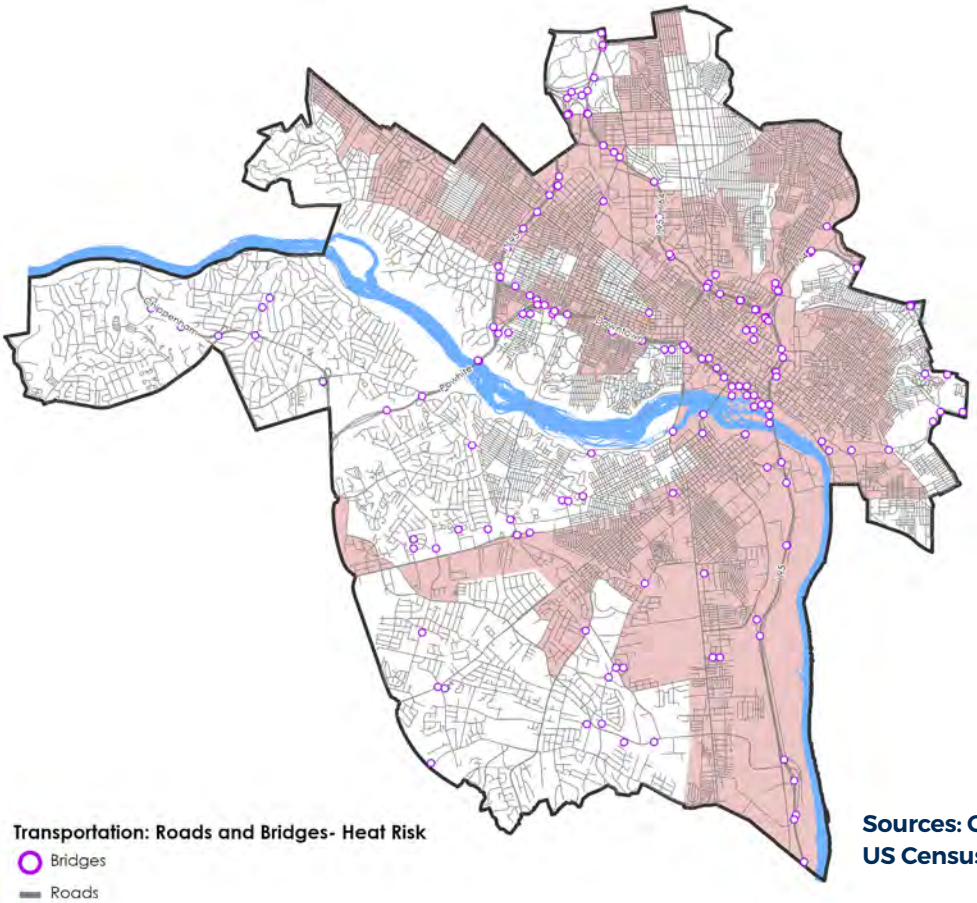
Resilience & Equity Impact Considerations

- The Capitol District running north-northeast to Rosedale and Bellevue has greater road density, and experiences more intense heating effects
- Recent storms have overwhelmed traditional mechanisms for managing roadway stormwater; areas of Southside experience substantial impacts
- In addition to roadway hazards, increased runoff contributes to combined sewer overflows
- Increased maintenance and replacement will be needed for miles of road

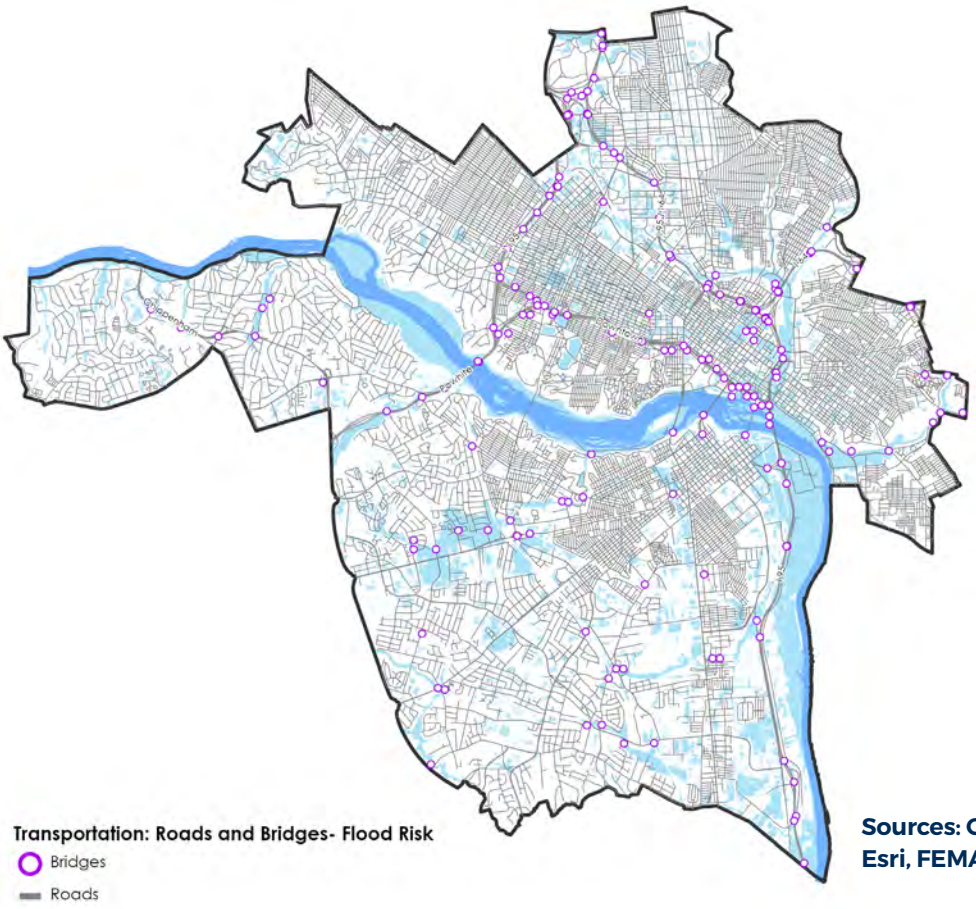
Built Assets at Risk

Roads and Bridges	Heat Risk	Flood Risk
Roads	640.3 miles	94.3 miles
Bridges*	107	62

*All bridges within areas of Flood Risk are identified. Note: bridge elevation data was not analyzed, therefore it is unknown which bridges may be inundated under the flood risk scenario.



Sources: City of Richmond, US Census Bureau



Sources: City of Richmond, Esri, FEMA

Transportation: Bicycle and Pedestrian Facilities

Heat
Med-High

Water
Med-High

Consequence
Med-High

The City of Richmond maintains more than 830 miles of sidewalks and has more than 71 miles of bicycle infrastructure primarily in the form of shared lane markings (sharrows) and bike lanes, along with nearly 16 miles of trails.. This network links to the East Coast Greenway, providing interregional connections. Richmond's temperate climate and rich natural amenities such as forests, rivers, and wetlands support interest in and development of walkable and bikeable communities.

Transportation Assets

- Bike infrastructure
- Bikeshare stations
- Pedestrian infrastructure
- Trails

Climate Vulnerabilities

- Flooding of trails, bike lanes, and sidewalks from storms and extreme precipitation events
- Potential inundation of low-lying trails near the James River from sea level rise
- Debris and mud over trails following storm and flooding events disrupting travel
- Extreme heat impacts to health, safety, and mobility for bicyclists and pedestrians, especially in urban heat island areas and locations with limited tree canopy

Resilience Factors

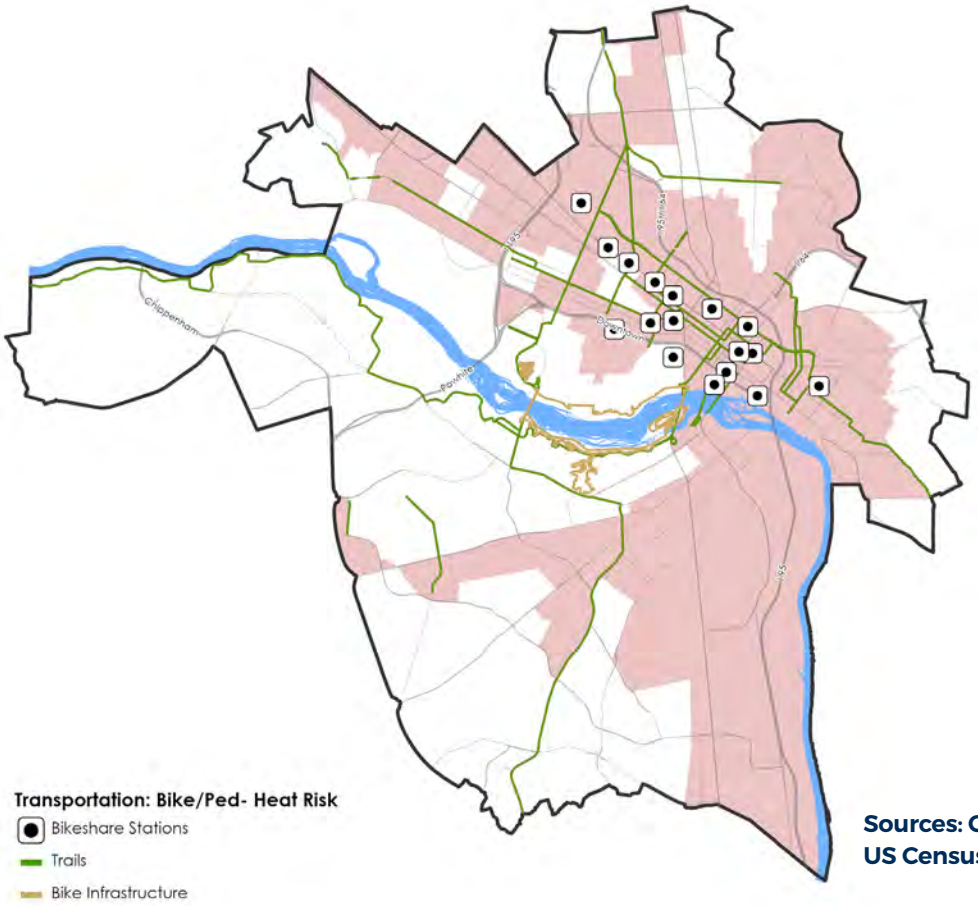
- Walkable, bikeable areas have greater community economic, health, mobility, and overall resilience

Resilience & Equity Impact Considerations

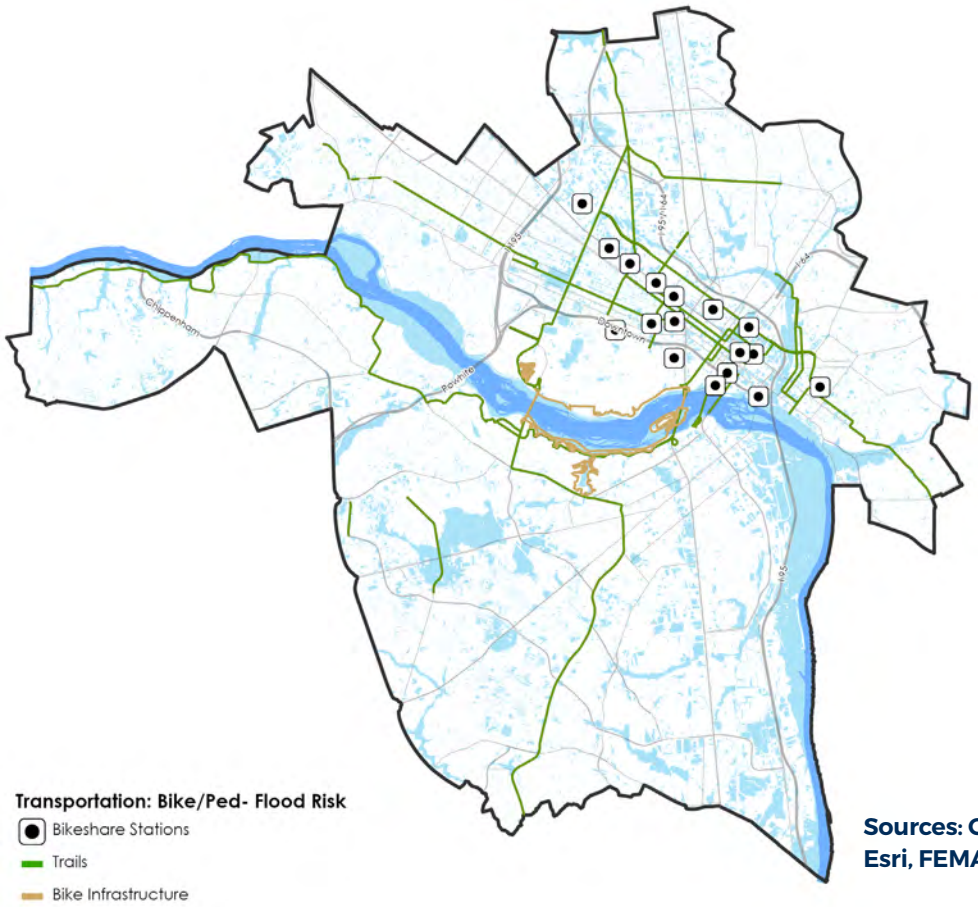
- Residents who rely on public transit, biking, and walking for transportation face increasing exposure to extreme weather conditions may have to forego trips for health or other essential purposes
- Richmond's trails and multi-use paths often lie in flat, low-lying areas prone to flooding

Built Assets at Risk

Transportation Assets	Heat Risk	Flood Risk
Bike Infrastructure	35.7 miles	11.3 miles
Bikeshare Stations	16	0
Trails	0.5 miles	4.7 miles



Sources: City of Richmond, US Census Bureau



Sources: City of Richmond, Esri, FEMA

Transportation: Rail and Transit

Richmond serves as a significant transportation hub for the Mid-Atlantic and entire East Coast. An Amtrak passenger train line and station intersects with the CSX freight rail line in Richmond. The Greater Richmond Transit Company provides fixed route bus service, Bus Rapid Transit along 7.6 miles of Broad and Main Street, paratransit services, and vanpool and carpool options.

Heat

Medium

Water

Med-High

Consequence

Med-High

Transportation Assets

- Major transit stations - Amtrak/Greyhound
- Rail bridges
- Railroads

Climate Vulnerabilities

- Flooding from storms and extreme precipitation events
- Service disruptions due to increased rain or prolonged flooding
- Extreme heat impacts to riders accessing transit, affecting health, safety, and mobility
- Higher demands for on-board air conditioning use during hotter days, increasing operating emissions and costs, and impacting any electrified transit resources
- Trains must reduce speeds during periods of high temperatures

Resilience Factors

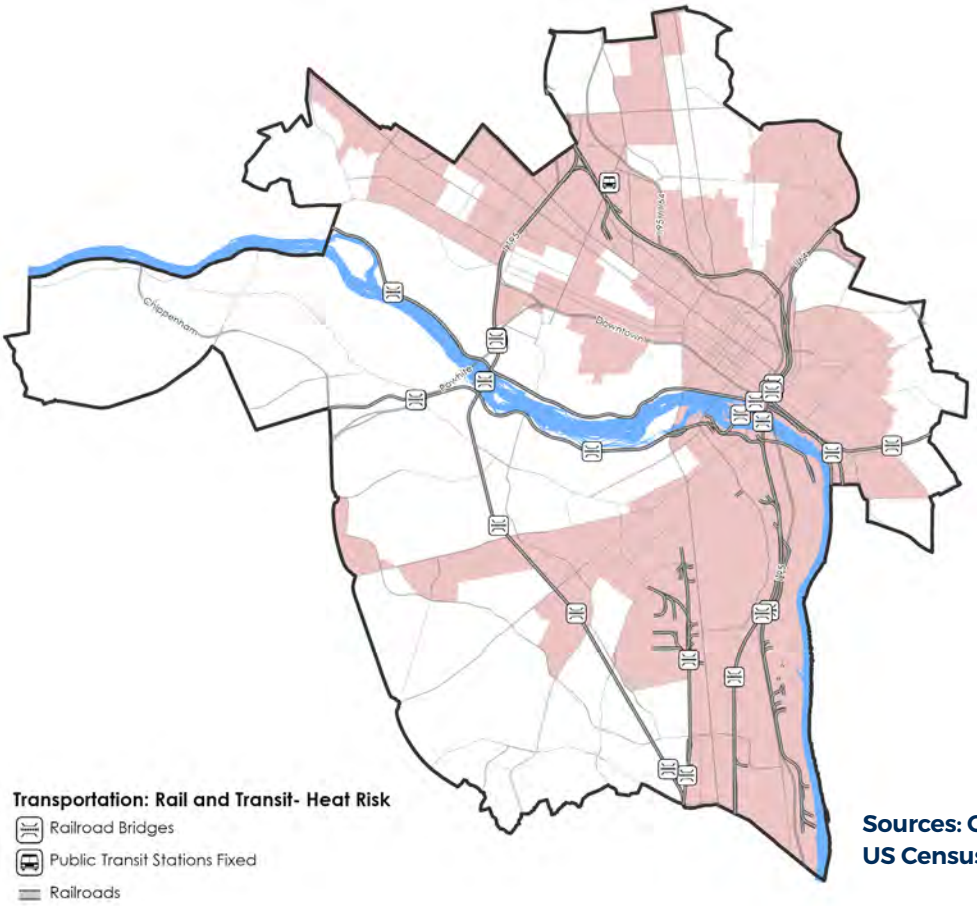
- Transit vehicles can be reallocated during emergencies to support evacuation efforts

Resilience & Equity Impact Considerations

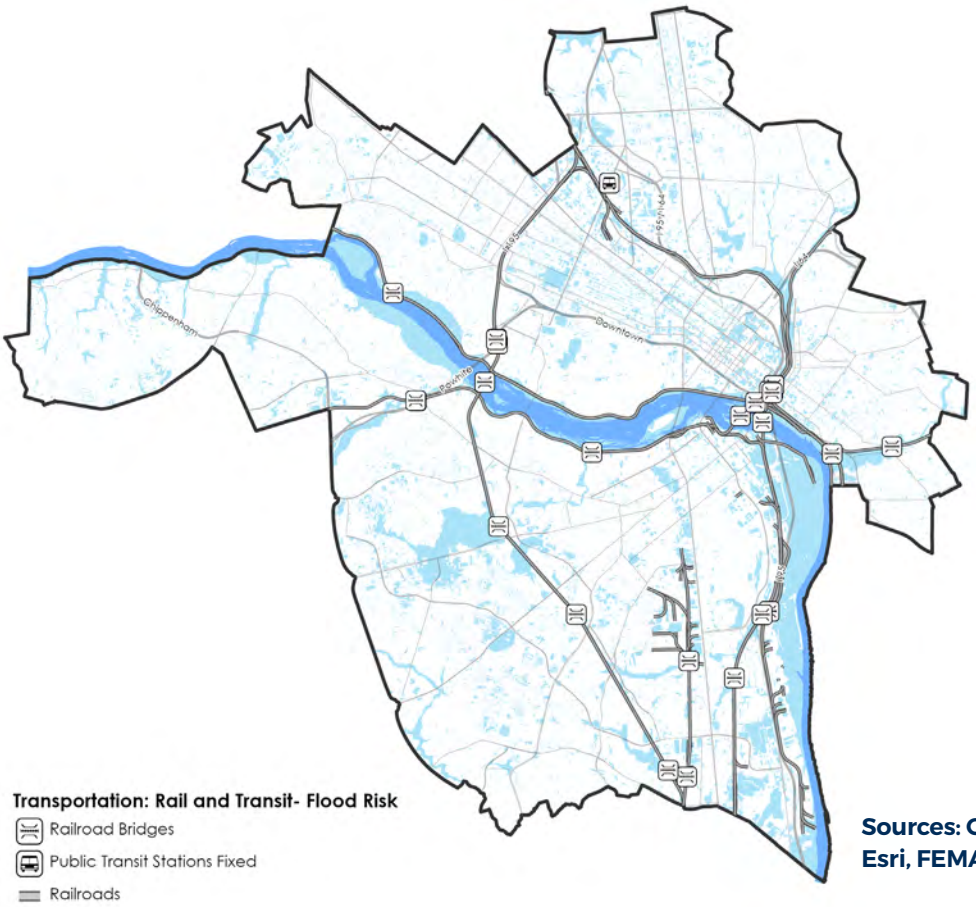
- Transit and rail, especially bus and paratransit, serve a higher proportion of frontline populations and these riders experience a greater burden when service is disrupted
- Vulnerable riders are more exposed to high heat and extreme weather impacts in accessing transit
- Shelter installation is a priority citywide, with focused funding for installations in the underserved neighborhoods
- Continued efforts are needed to install shelters, enhance shelter designs, and plant trees at transit stops and access pathways

Built Assets at Risk

Rail and Transit	Heat Risk	Flood Risk
Major Transit Stations - Amtrak/Greyhood	2	2
Railroad Bridges	14	15
Rail lines	112.5 miles	57.7 miles



Sources: City of Richmond, US Census Bureau



Sources: City of Richmond, Esri, FEMA

Transportation: Marine

The Richmond Marine Terminal (RMT) is a uniquely important asset to Richmond and the region. It is "the western terminus for commercial navigation on the James River and is the westernmost commercial maritime port on the North Atlantic coast" (City of Richmond, 2022) and has the quickest access to I-95 of any port.

Heat

Low

Water

Med-High

Consequence

Med-High

Transportation Assets

- Richmond Marine Terminal

Climate Vulnerabilities

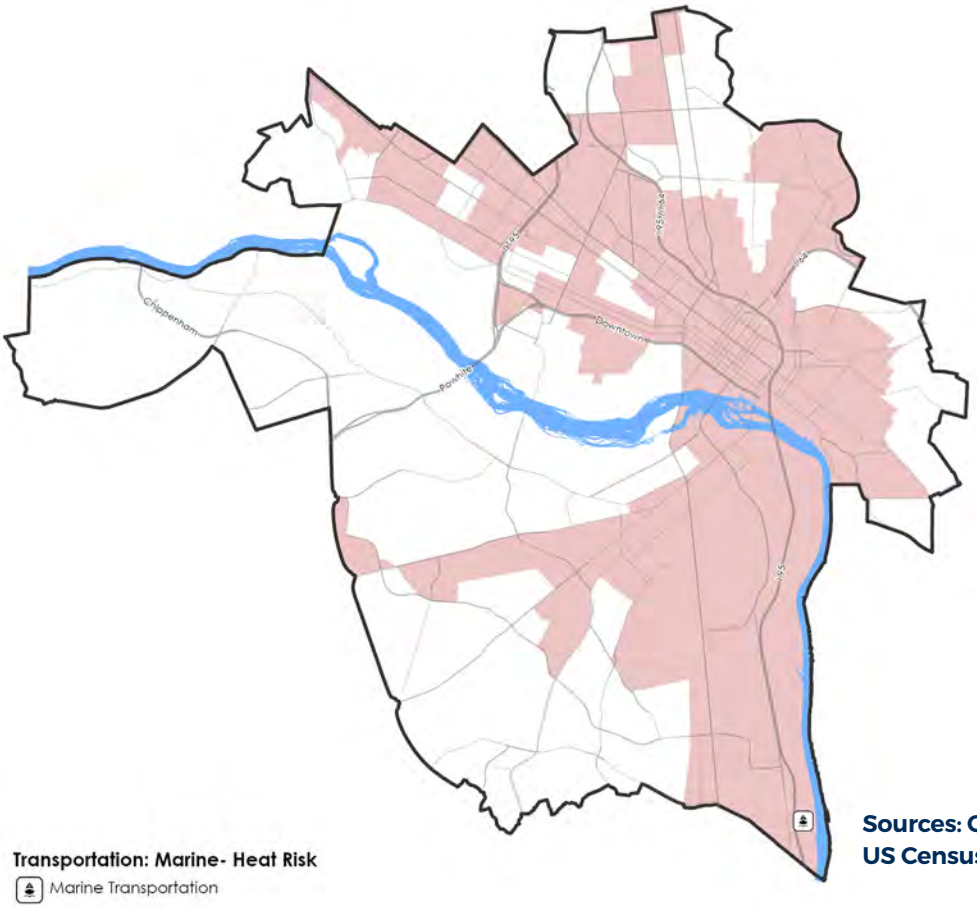
- Flooding from extreme precipitation events
- Sea level rise will impact flooding vulnerability, RMT facilities, and port operations
- Flooding on roadway network and rail lines accessing the port
- Debris from extreme storms and flooding events

Resilience & Equity Impact Considerations

- RMT is susceptible to increased flooding given its location along the tidal James River
- Landing facilities and access to docks where cargo and passengers are transferred are at risk
- Many goods are shipped through this port, making it a key employment center and community economic resource

Built Assets at Risk

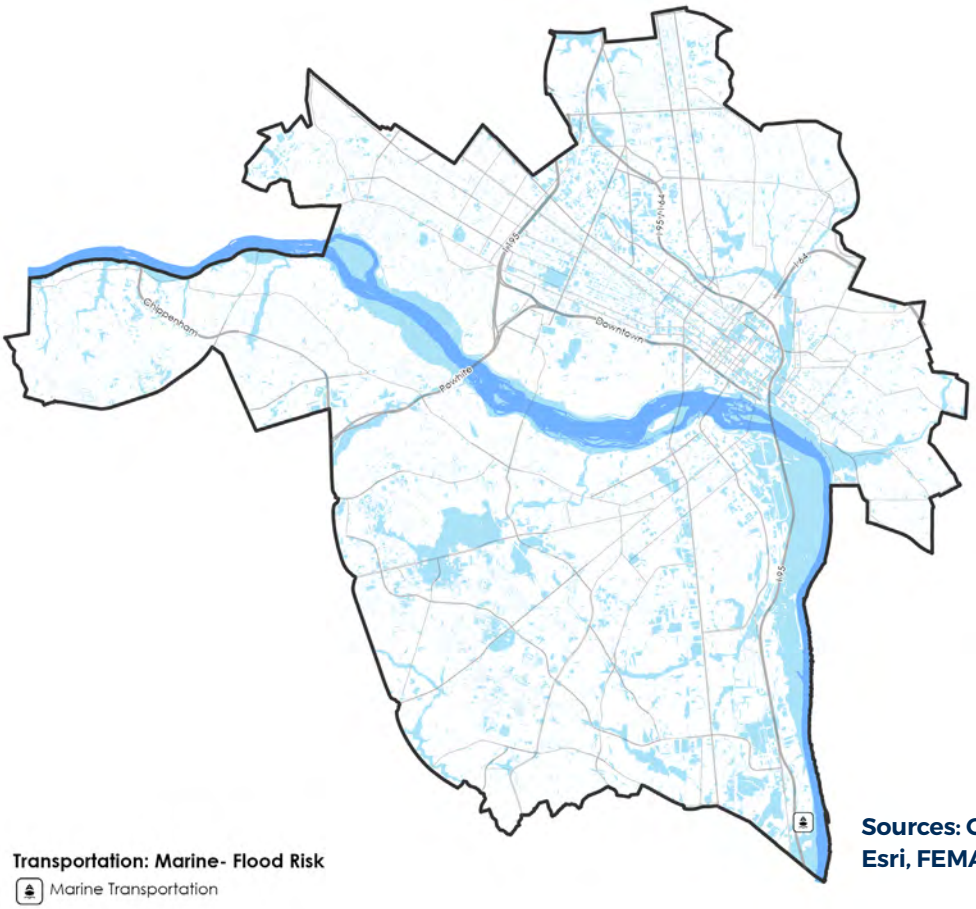
Marine Transportation	Heat Risk	Flood Risk
Marine	1	1



Transportation: Marine- Heat Risk

Marine Transportation

Sources: City of Richmond, US Census Bureau



Transportation: Marine- Flood Risk

Marine Transportation

Sources: City of Richmond, Esri, FEMA

Transportation: Richmond International Airport

Richmond International Airport is located outside the City of Richmond boundary, but is a key resource for passenger travel and movement of goods in and out of the area. Aircraft operations are particularly susceptible to changes in temperature and humidity. The changing climate will have persistent effects on operations and planning.

Heat
Med-High

Water
Med-High

Consequence
Med-High

Transportation Assets

- Richmond International Airport

Climate Vulnerabilities

- Extreme heat impacts to runways (warping and buckling), affecting take-off and landing capabilities at the airport
- Length of runway needed to take off and weight planes can carry affected by heat
- Increasing storm frequency and severity pose risks to air travel
- Microburst storms are a major concern for airport operations

Resilience & Equity Impact Considerations

- Flight disruptions can have significant economic effects
- Impacts to air travel affect mail and goods
- Runways will require additional maintenance

Built Assets at Risk

Transportation Assets	Heat Risk	Flood Risk
Richmond International Airport	Not included in city boundaries	Not included in city boundaries

Waste Management

Richmond's waste management system includes municipal and private solid waste services, recycling, and composting. Maintaining effective waste management systems helps promote public health. Also considered in this category are facilities regulated by the Environmental Protection Agency (EPA) due to the handling or storage of toxic substances. A recent report links climate change to toxic chemical spills specifically in the James River watershed as a significant threat to the region.

Heat

Medium

Water

Med-High | High

Consequence

Med-High | High

Waste Management Assets

- Composting, recycling and municipal solid waste facilities
- EPA emergency response facilities
- Solid waste landfill facilities

Climate Vulnerabilities

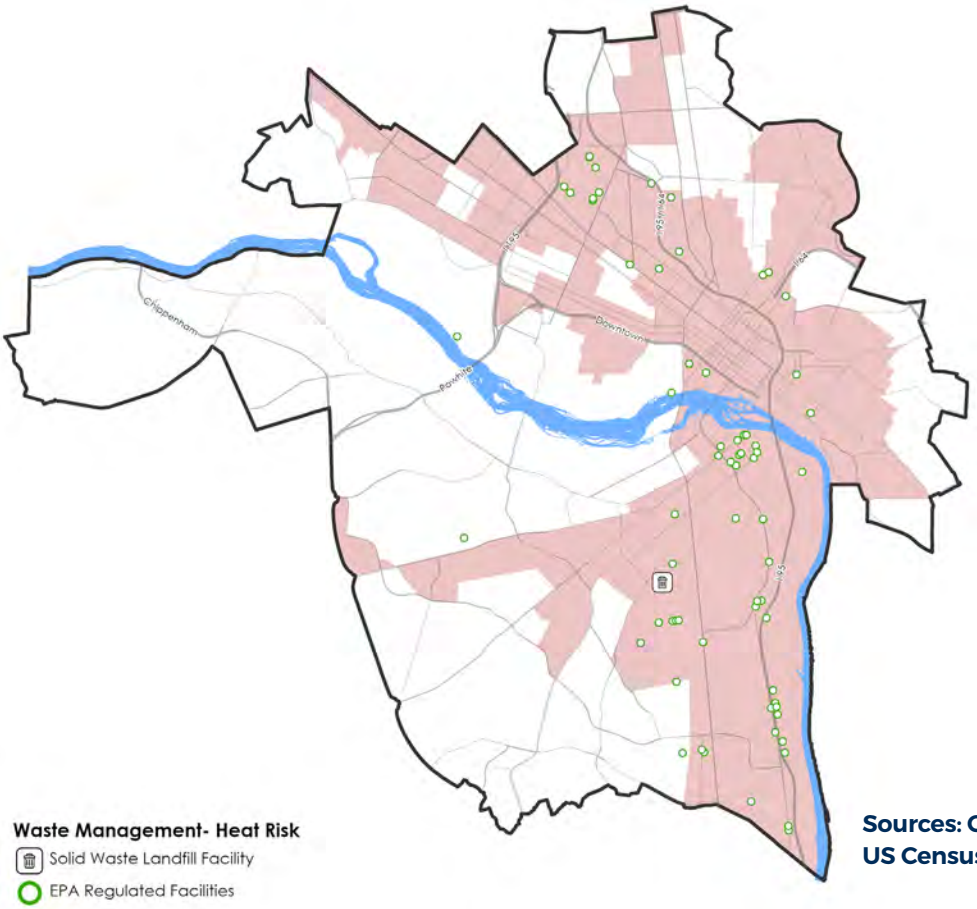
- Flooding and runoff impacts to solid waste facilities, especially East Richmond landfill, and waste collection routes
- Littering and unregulated dumping in ravines increases debris during storm events, which can overwhelm the waste management system and contribute to contamination of water supply and sensitive habitats
- Sea level rise impacts to facilities next to the James River
- Increased heat and humidity impacts to bacteria and nutrient loads, which can seep into the environment
- Extreme heat impacts to workers at waste facilities and on collection trucks

Resilience & Equity Impact Considerations

- Potential for flooding and stormwater runoff from landfills to contaminate surrounding areas; the environment should be monitored for bacteria leaks and mitigation could be performed
- Future need to update waste facilities sizing
- Address alley trash collection issues, including that they can't be served by automated trucks
- Explore and better understand medical waste from hospitals and universities
- Implement work practices for waste management crews such as shifted hours and staggered crews to manage increased heat and intense storm

Built Assets at Risk

Waste Management Assets	Heat Risk	Flood Risk
EPA Emergency Response	75	14
Solid Waste Landfills	1	0

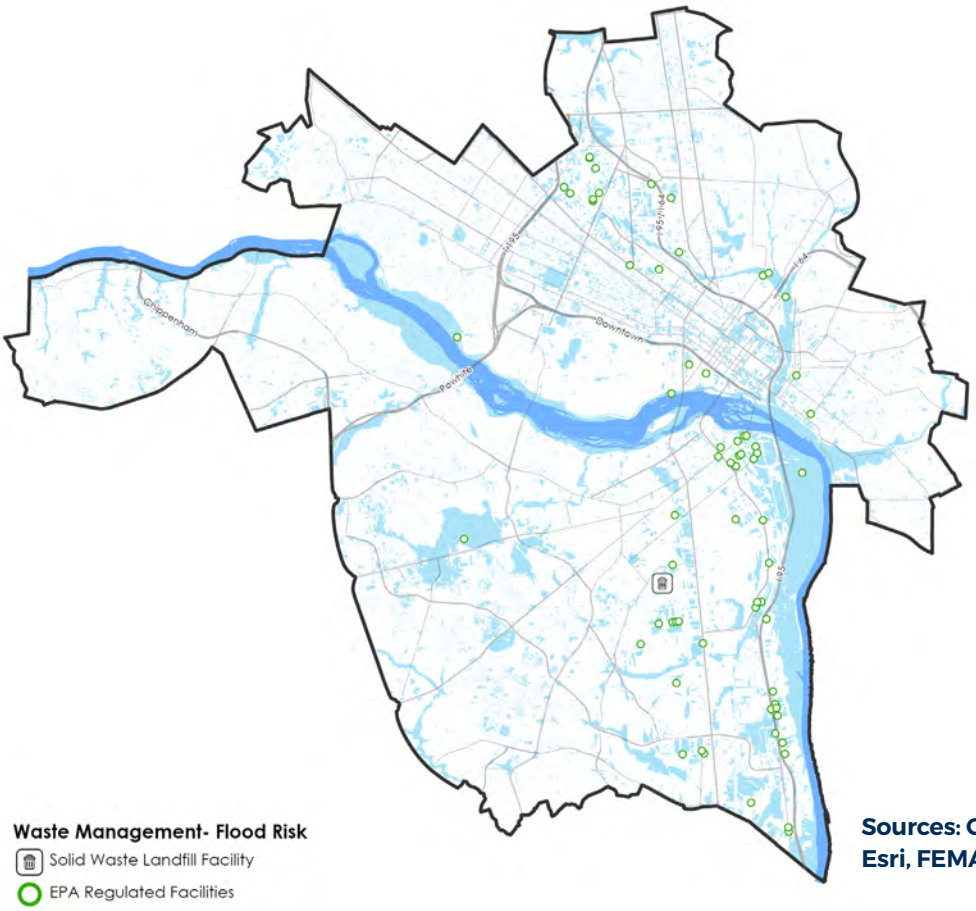


Waste Management- Heat Risk

Solid Waste Landfill Facility

EPA Regulated Facilities

Sources: City of Richmond, US Census Bureau



Waste Management- Flood Risk

Solid Waste Landfill Facility

EPA Regulated Facilities

Sources: City of Richmond, Esri, FEMA

Water Supply

Water supply infrastructure ensures that Richmond residents have a reliable, clean source of water. The James River is the primary water source for the City.

Heat

Medium | Med-High

Water

Med-High | High

Consequence

High

Water Supply Assets

- Dams
- Water pipes
- Water treatment facilities

Climate Vulnerabilities

- Increasing heat and periods of drought
- Growth of biota, algal blooms, bacteria and viruses, eutrophication, water quality issues, and treatment facility maintenance risks
- Periods of water demand exceeding supply
- Severe storm and flooding impacts to water treatment capacity, temporary potable water impacts

Resilience Factors

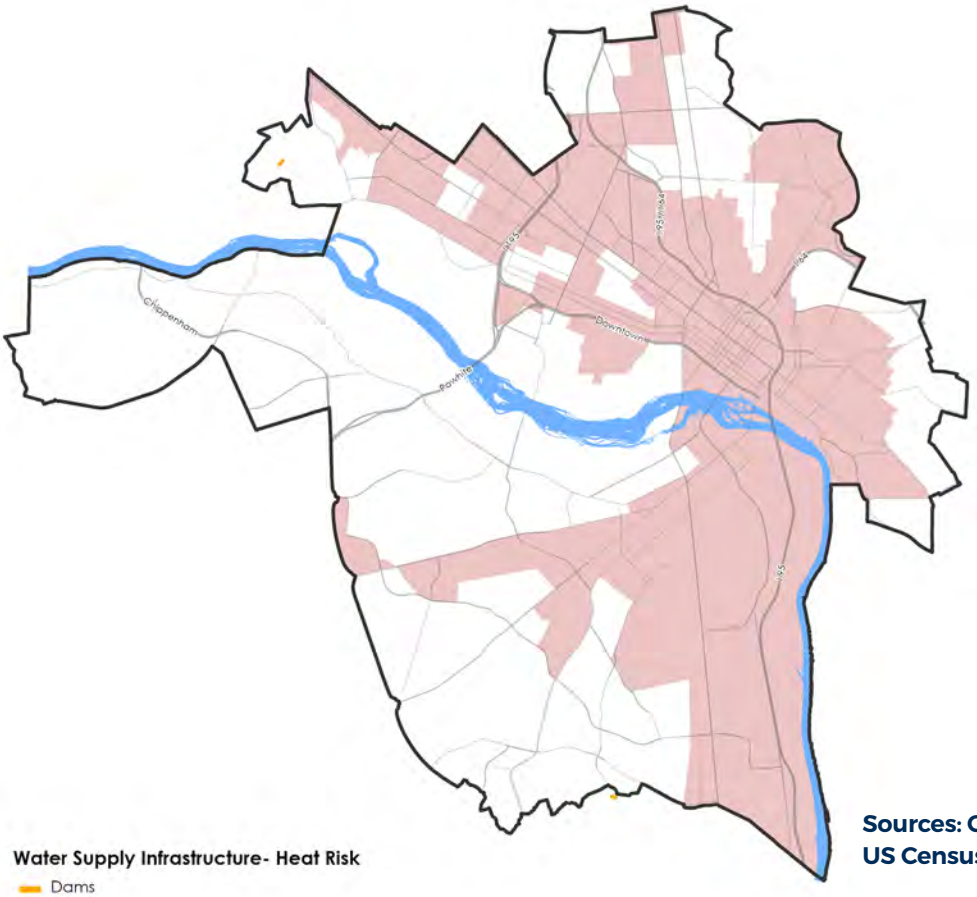
- Through initiatives like smart sensors, RVAH2O, the City of Richmond's collaborative, long-term clean water effort, is improving adaptive capacity, but the system is still largely a hard infrastructure with minimal flexibility.

Resilience & Equity Impact Considerations

- Meeting water demands for maintaining and growing vegetation and tree canopy
- Potential for development of improved technologies to utilize stormwater runoff
- Green infrastructure needed, some planning initiatives underway

Built Assets at Risk

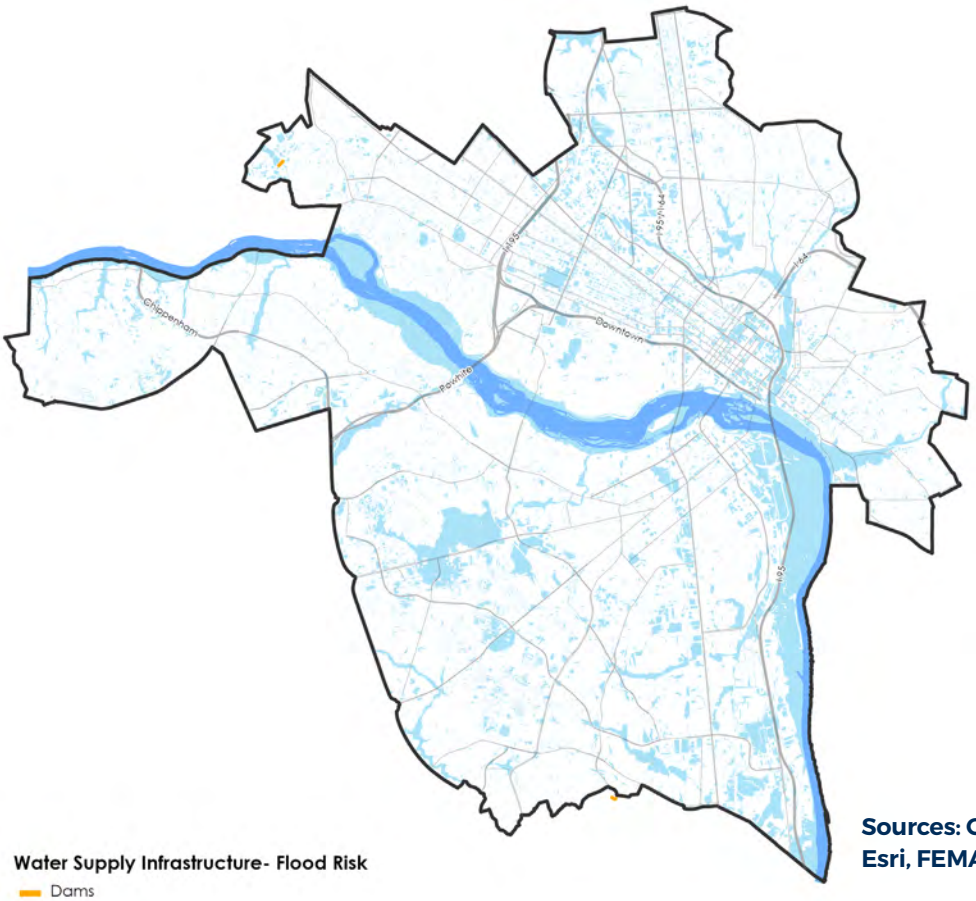
Water Supply Assets	Heat Risk	Flood Risk
Dams		
Water Pipes		
Water Treatment Facilities		



Water Supply Infrastructure- Heat Risk

Dams

Sources: City of Richmond, US Census Bureau



Water Supply Infrastructure- Flood Risk

Dams

Sources: City of Richmond, Esri, FEMA

Natural Assets Vulnerability and Risk

Natural assets were identified by considering the landscape, habitats, and water features present in Richmond. These include assets both internal and external to the City's operational control.

Parks & Open Space

Terrestrial Habitat

Trees and Vegetation

Water Bodies

Parks & Open Space

Parks and open spaces play an essential role in supporting health and well-being for Richmond residents. Parks offer opportunities for residents to spend time outdoors and engage in an active, healthy lifestyle.

Heat

Medium | Med-High

Water

Medium | Med-High

Consequence

High

Parks and Open Spaces Assets

- Cemeteries
- Community gardens
- Parks and playgrounds

Climate Vulnerabilities

- Extreme heat, storms, and flooding can limit people's ability to use parks
- Plants and trees in parks and open spaces filter
- Increased invasive species
- Soil destabilization due to vegetation impacts and extreme precipitation events
- Impacts to carbon cycle and decrease in carbon sequestration due to soil impacts
- Decreases or changes to biodiversity patterns
- Park land and open space along the James River in areas impacted by river flooding

Resilience Factors

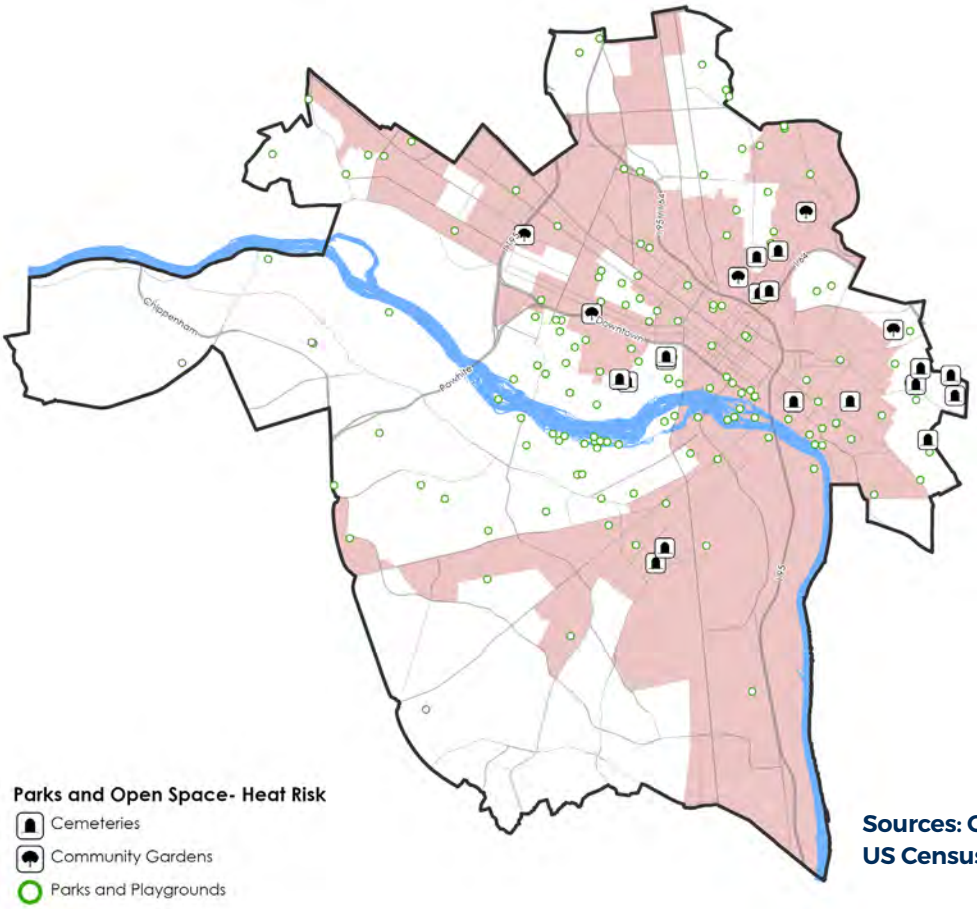
- Parks may provide tree canopy for cooling relief during heat waves
- Plants and trees in parks and open spaces filter stormwater runoff and provide capacity for accommodating excess rainfall from extreme precipitation events

Resilience & Equity Impact Considerations

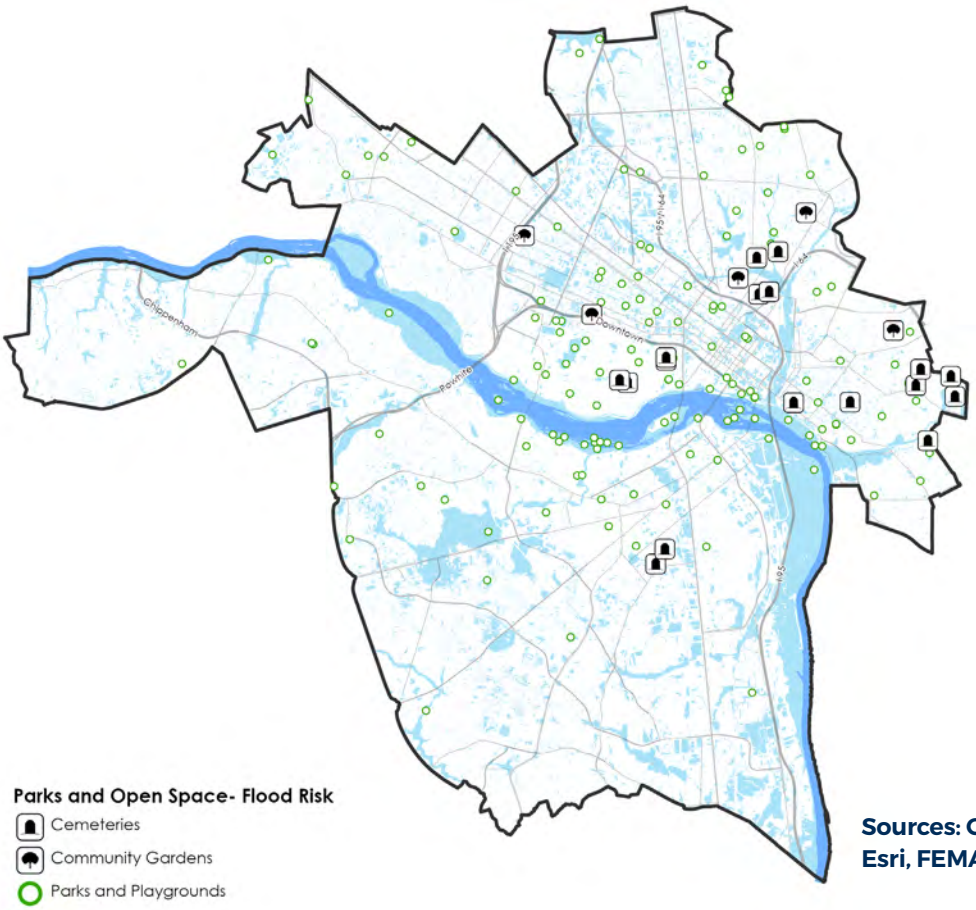
- Address equity considerations and mitigation needs to redress past harms based on historic approaches to cemeteries, burial grounds, and sacred sites for minority communities
- Prioritize cemeteries as green infrastructure within the City
- Interest in increasing green spaces and resilience, including urban gardens
- Water usage impacted by periods of drought
- Increased maintenances costs
- Loss of land with potential to support local food systems

Natural Assets at Risk

Parks and Open Spaces	Heat Risk	Flood Risk
Cemeteries	7	2
Community Gardens	4	0
Parks and Playgrounds	72	47



Sources: City of Richmond, US Census Bureau



Sources: City of Richmond, Esri, FEMA

Terrestrial Habitat

Terrestrial, or land-based, habitats support native plants and wildlife species. Like other open spaces, they also provide refuge from urban heat and support stormwater management. Key habitats include protected natural areas and James River islands. The maps on the following page show terrestrial habitats designated by the Northeast Climate Science Center and North Atlantic Landscape Conservation Cooperative, as mapped by the Natural Conservancy Eastern Conservation Science team.

Heat

Med-High

Water

Med-High

Consequence

High

Habitat Assets

- Terrestrial habitat features
- James River islands

Climate Vulnerabilities

- Most areas are located in flood zones and sensitive to flooding
- Rising water levels along James River and tributaries because of rising sea levels
- Disappearance or shrinking of islands
- Inundation of protected and sensitive lands
- Sensitivity to heat changes
- Migration of species
- Threats from invasive species

Resilience Factors

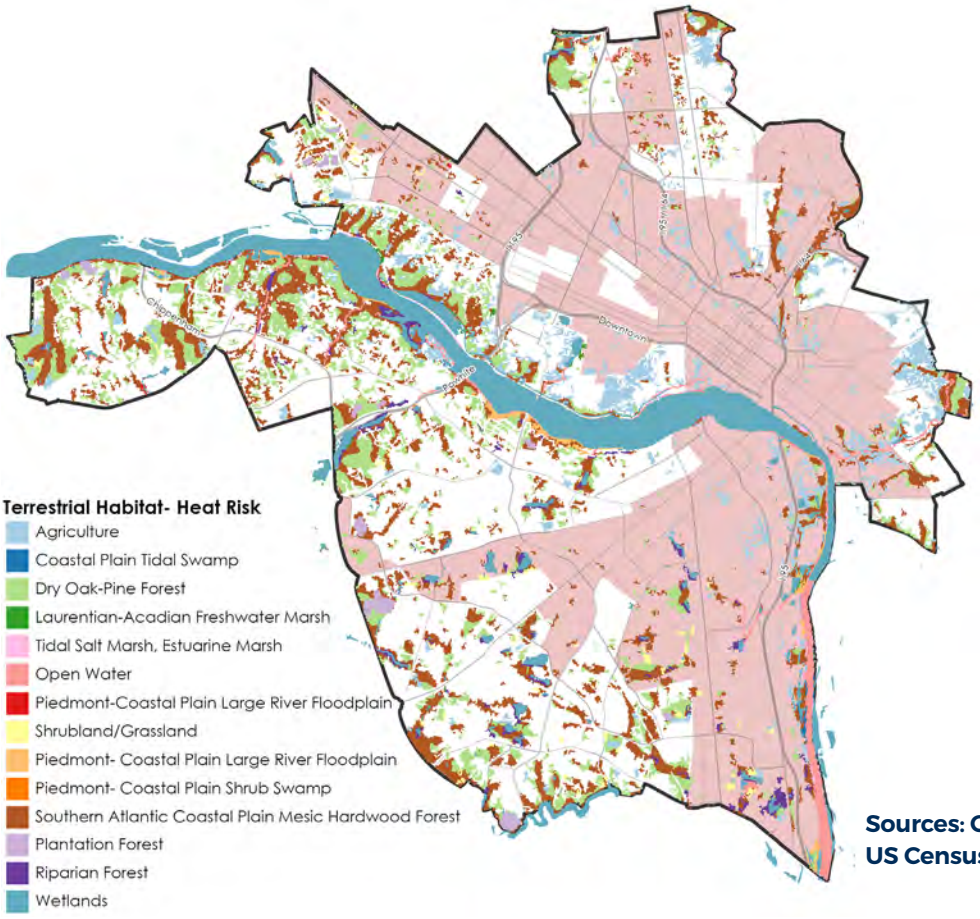
- Easement and impervious surface limitations provide protection for some areas
- Protected and natural areas currently provide relief from heat waves and help accommodate storm runoff

Resilience & Equity Impact Considerations

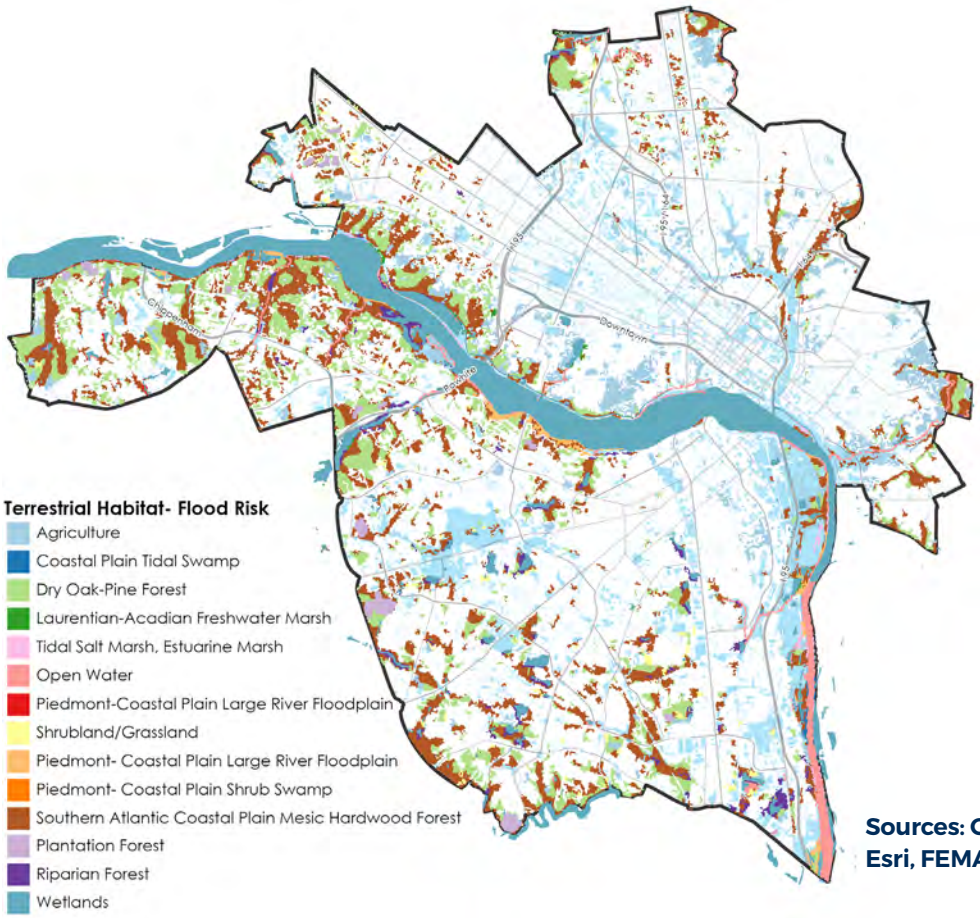
- Impacts will be substantial to James River islands and habitats along the James River due to sea level rise
- Planning for major impacts to James River Islands should be prioritized
- Land use and development pressures reduce space for climate resilience
- Increase green spaces to support natural world and human communities

Natural Assets at Risk

Habitat Assets	Heat Risk	Flood Risk
Habitat features	13	14
James River Islands	7	15



Sources: City of Richmond, US Census Bureau



Sources: City of Richmond, Esri, FEMA

Trees & Vegetation

Trees and vegetation include those found in open spaces and those integrated into the urban fabric. They provide valuable carbon sequestration, shading and refuge from the heat, and support for better air quality. Trees and vegetation also provide refuge and safe passage for wildlife and pollinators. Isolated trees and tiny pockets of vegetation can be just as critical as larger tracts of undisturbed land.

Heat

Med-High

Water

Med-High

Consequence

High

Trees & Vegetation Assets

- Tree canopy
- Vegetation and other pervious surface cover

Climate Vulnerabilities

- Flooding and inundation of vegetation along the river
- Storm damage to tree limbs
- Heat and/or water stress during periods of drought
- Changing native ranges of plant species
- New pests moving into the area as winter freeze line moves northward
- Effects on native species can increase opportunities for invasive species

Resilience Factors

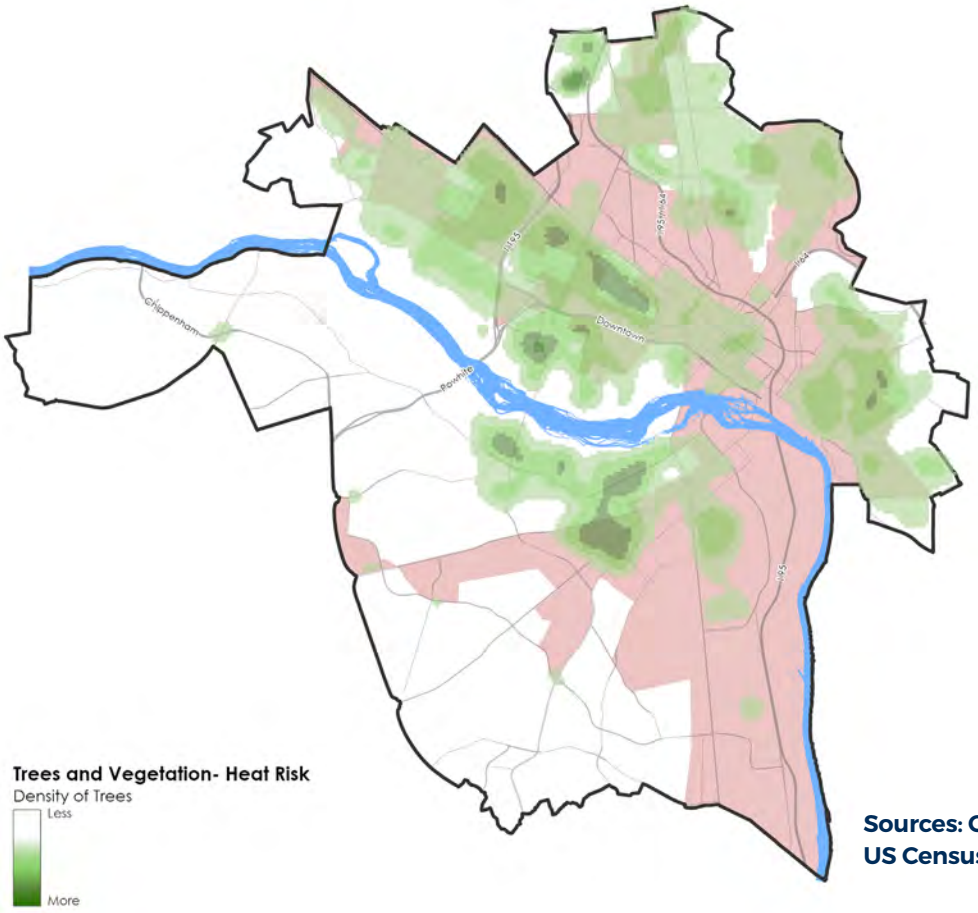
- Past efforts have focused on planting trees and increasing vegetation
- Plants have some adaptive capacity, but generally with new species replacing species that do not survive changes
- Areas of tree plantings and vegetation provide relief from heat waves and help accommodate storm runoff

Resilience & Equity Impact Considerations

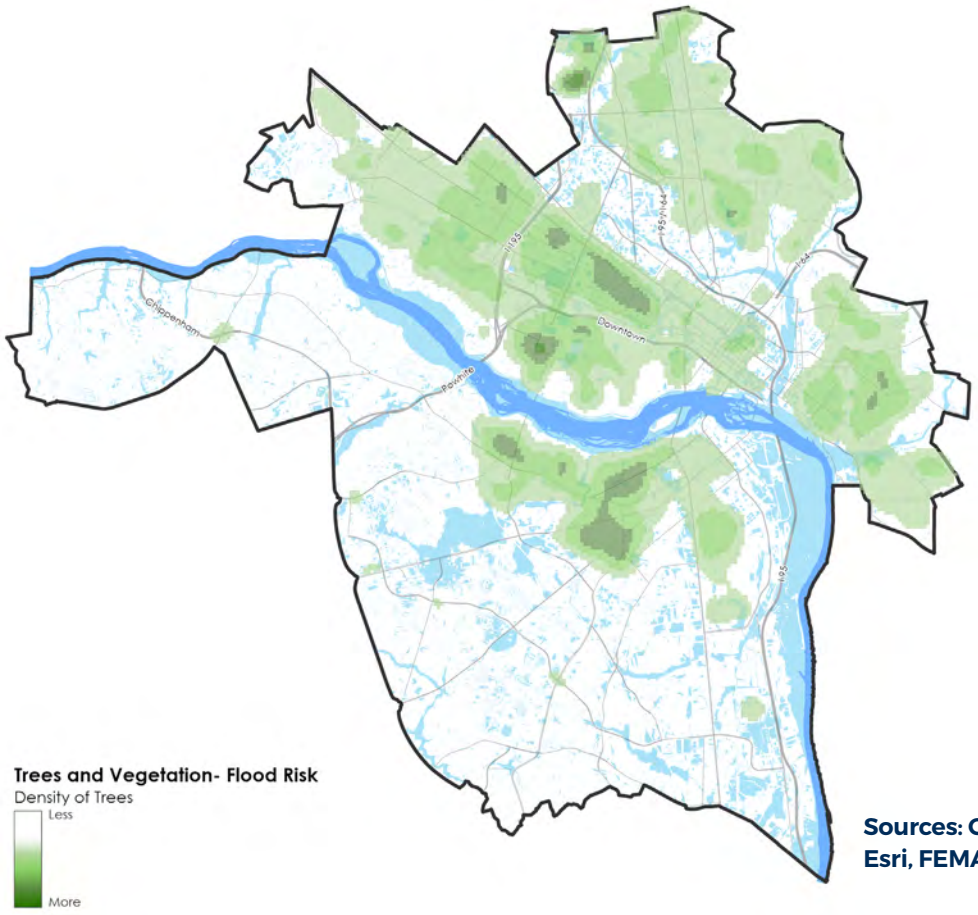
- Tree limbs broken off in storms may cause power outages and property damage
- Loss of trees may lead to worsening heat effects, decrease in air quality, soil erosion, and public health impacts
- Trees and vegetation should be replaced with more heat and drought tolerant native species.
- Adding trees can increase the City's tree canopy and moderate climate impacts
- Equity should be considered for areas with low tree cover

Natural Assets at Risk

Trees and Vegetation	Heat Risk	Flood Risk
Trees	61396	9597



Sources: City of Richmond, US Census Bureau



Sources: City of Richmond, Esri, FEMA

Water Bodies

Rivers, lakes, and streams are among the most sensitive resources to climate threats. They provide water storage, pathways for floodwaters, support aquatic habitats, and support human activities. Water bodies are also important for food supply and economic activity.

Heat

Med-High

Water

Med-High

Consequence

High

Water Bodies/Assets

- Chesapeake Bay Protection Area
- Creeks
- Lakes

Climate Vulnerabilities

- Permanent changes to the average water level
- Flooding of water bodies and resources that surround them
- Fundamental changes to aquatic habitats because of rising temperatures
- Decreased dissolved oxygen, changes to the nutrient balance, increased pollution effects, and increased algal blooms

Resilience Factors

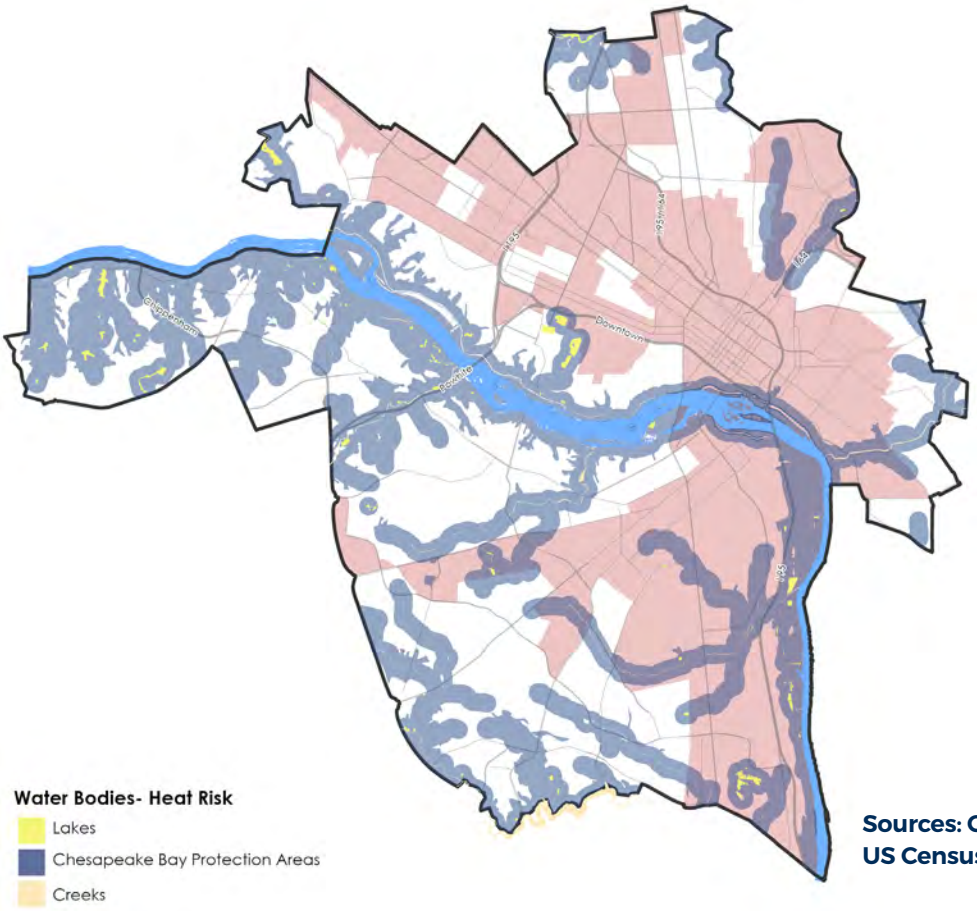
- Water bodies provide some relief to natural and human communities during heat waves
- Water resources have some adaptive capacity to accommodate extreme precipitation and runoff, but impacts over time can result in permanent changes to aquatic habitats and biotic systems

Resilience & Equity Impact Considerations

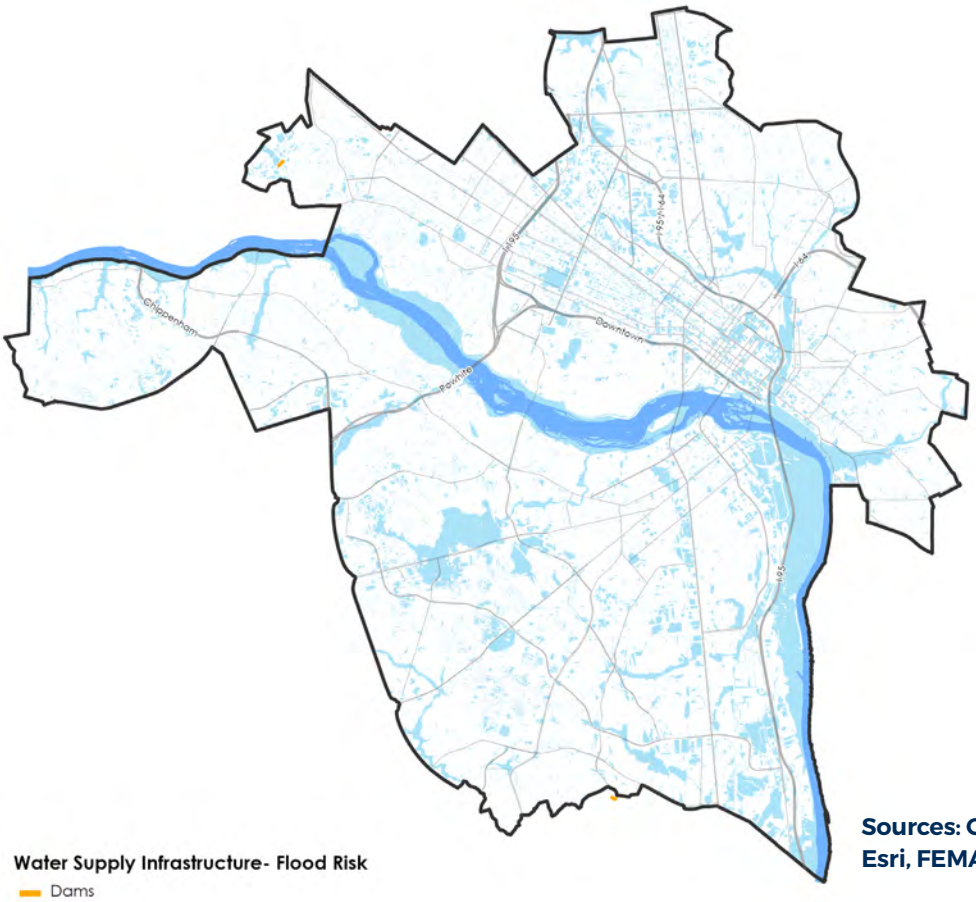
- Dependence by natural communities and humans on food from the river
- Distributional equity in access to water bodies and higher quality water resources

Natural Assets at Risk

Water Bodies	Heat Risk	Flood Risk
Chesapeake Bay Protection Area	3782.3 acres	3410 acres
Creeks	10	31
Lakes	28	92



Sources: City of Richmond, US Census Bureau



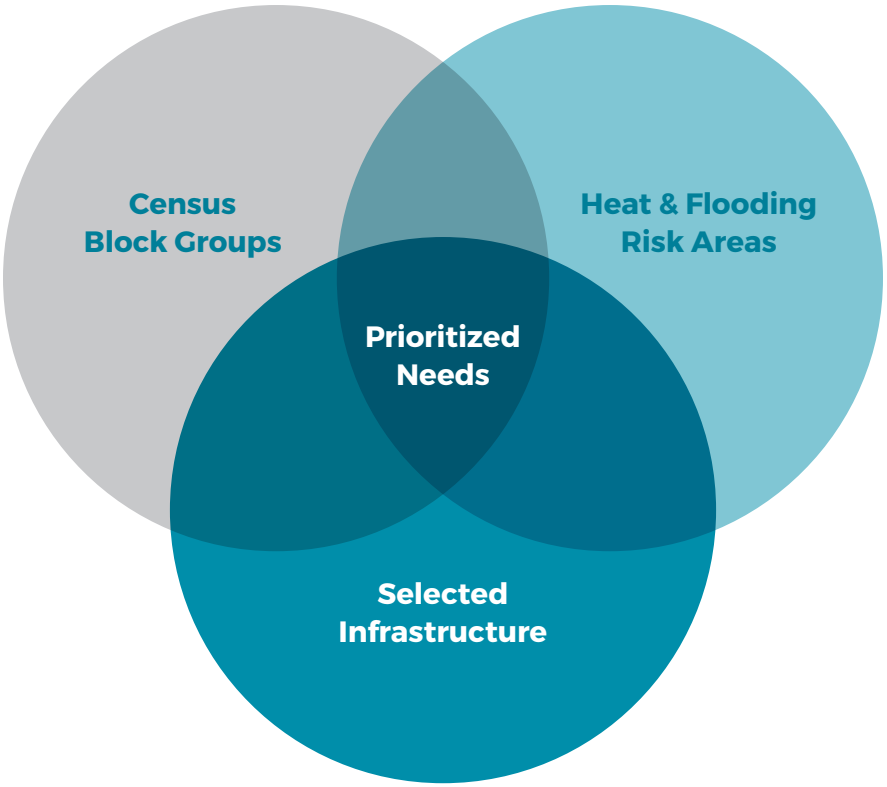
Sources: City of Richmond, Esri, FEMA

6. Priority Planning Areas

Heat and flooding risks to Richmond's built and natural assets (Section 5) are overlaid with social vulnerability (Section 4) in order to determine priority areas for actions and interventions for enhanced climate resilience.

6.1 Prioritization Methodology

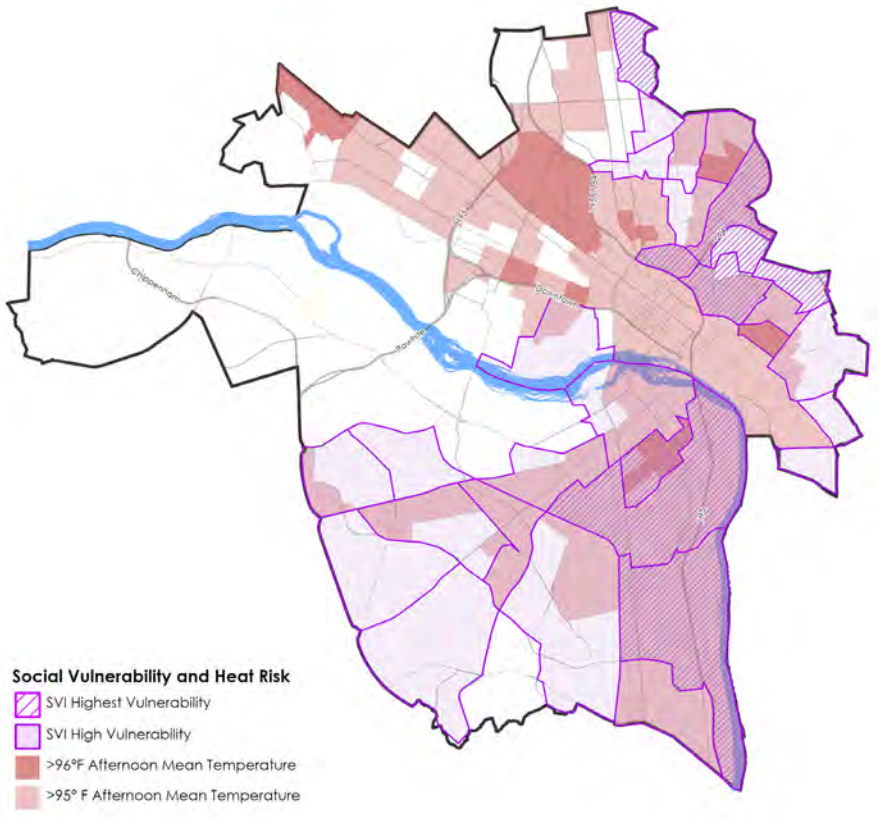
The previous section described the built and natural assets and infrastructure that are vulnerable to climate risks This section applies the social vulnerability information from the City's Climate Equity Index to prioritize climate and resilience actions based on risks to assets that will have the greatest impact to Richmond's frontline communities. Mapping analysis is used to focus on assets in socially vulnerable areas or serving socially vulnerable groups.



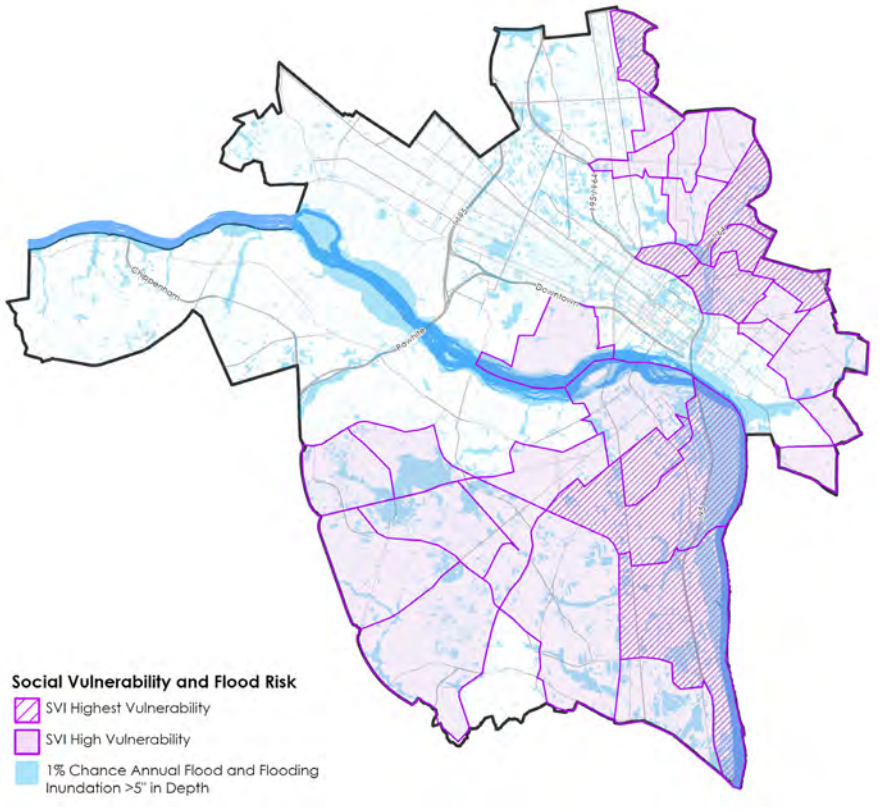
Priority Planning Areas / Prioritized Needs – Highly Vulnerable populations, including populations identified as "Highly" Vulnerable and "Most" Vulnerable from the Climate Equity Index were overlaid with areas facing heat and flooding risk. Assets specifically serving socially vulnerable groups subject to these risks were also included, such as homeless facilities, public housing, and food pantries. These broad planning areas should be considered for prioritization through mid and long term solutions.

Critical Prioritized Needs / Planning Areas – after identifying the priority planning areas for highly vulnerable populations and assets, those assets falling within census areas containing populations identified as the "Most" Vulnerable from the Climate Equity Index were identified, including the names of these assets. These critical prioritized needs can help in determining the most impactful climate and resilience actions for short term and mid-term solutions, especially in consideration of resource or funding constraints. Consequence scores which indicate the magnitude of repercussions for the community if climate impacts occur, are presented alongside the critical vulnerable assets to further support City prioritization of strategies and action.

Information on heat and flood priority planning areas and critical prioritized needs are summarized in the following sections with supporting detail presented in more detail in Appendices E and F.



Sources: City of Richmond, Esri, US Census Bureau



Sources: City of Richmond, Esri, FEMA, US Census Bureau

6.2 Prioritized Needs – Heat Vulnerability

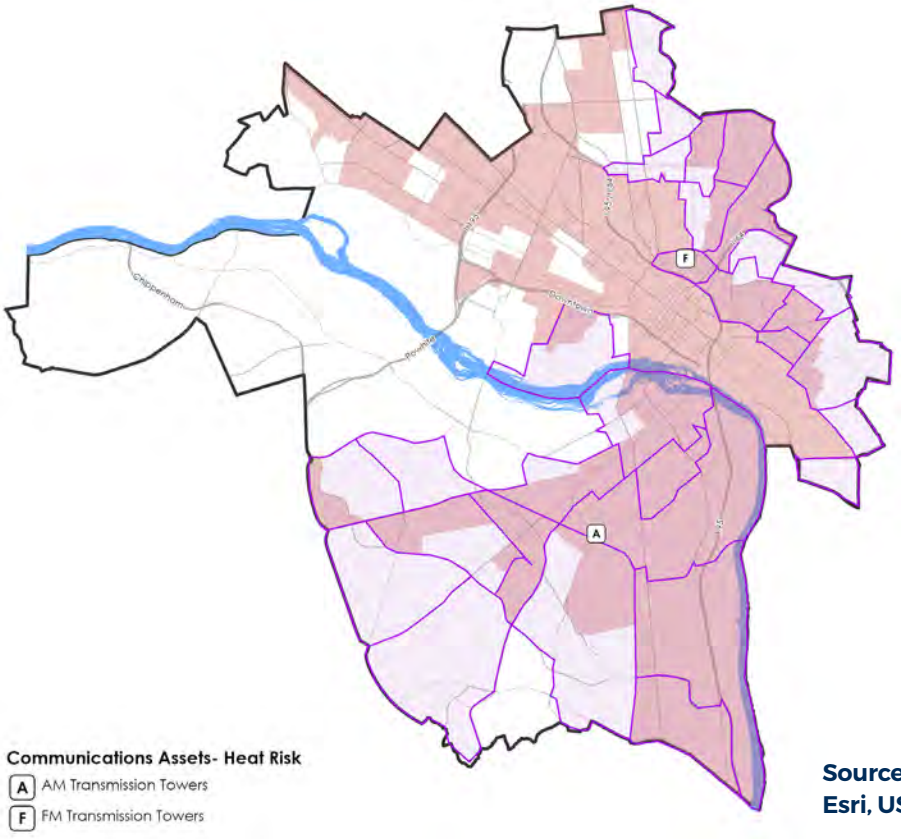
Table 6.1 summarizes the assets in socially vulnerable areas or that predominantly or exclusively serve socially vulnerable groups regardless of location that have exposure to heat risk from climate change (Census block groups with afternoon mean high temperatures above 95˚F). The map figures on the pages that follow illustrate the location of assets with exposure to heat risk for each category or grouping of assets of similar types.

Table 6.1 - Priority Planning Areas - Heat Risk

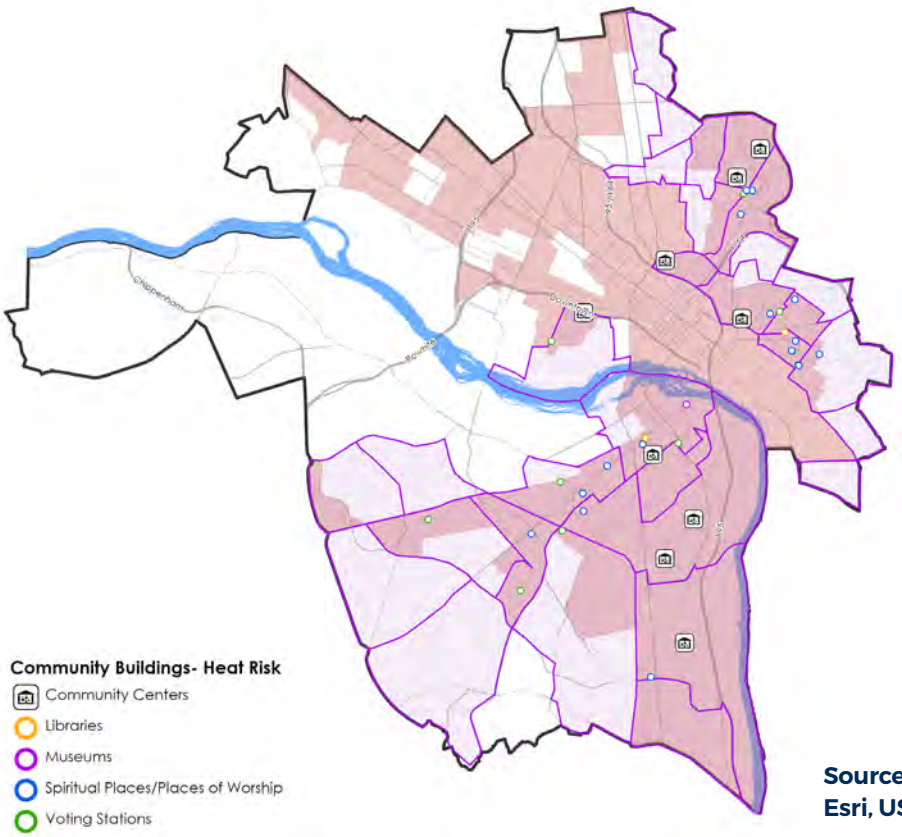
Asset Category	Asset Name	Total City-wide	Units	Heat Risk - Afternoon Mean High Temp >95*	
				Assets at Heat Risk in Highly Socially Vulnerable (SV) Areas	Assets Serving SV Groups at Heat Risk Outside Highly SV Areas
Communications Infrastructure	AM Transmission Towers	3	towers	1	0
	FM Transmission Towers	5	towers	1	0
Community Buildings	Community Centers	22	centers	9	0
	Libraries	13	libraries	2	0
	Museums	37	buildings	1	0
	Religious Centers	74	Centers	16	0
	Voting Stations	67	stations	16	0
Education	Childcare Centers	118	centers	33	0
	K12 Public Schools	44	schools	9	0
	Private Schools	34	schools	4	0
Health and Social Services	Dialysis Clinics	5	clinics	1	2
	Homeless Facilities	5	facilities	1	4
	Hospitals	6	hospitals	2	0
	Nursing Homes	17	homes	5	6
	Social Services	3	services	1	0
Historic	City Historic Districts	45	districts	2	0
	National Register Historic Districts	133	Districts	22	0
	State Federal Historic Sites	156	sites	16	0
Economic Development and Planning	CARE Zones	13	zones	10	2
	Enterprise Zones	4	zones	3	1
	Enterprise Zones Community Unit Plans	110	zones	28	0

Asset Category	Asset Name	Total City-wide	Units	Heat Risk - Afternoon Mean High Temp >95*	
				Assets at Heat Risk in Highly Socially Vulnerable (SV) Areas	Assets Serving SV Groups at Heat Risk Outside Highly SV Areas
Energy Infrastructure	Biodiesel Plants	1	facilities	1	0
	Electrical Substations	1	substations	37.7	0
	Electric Vehicle Charging Stations	134	stations	16	0
	NaturalGas Pipeline	1.6	miles	0.2	0
	Non Gasoline Alternative Fueling Stations	13	stations	4	0
	Petroleum Ports	1	ports	1	0
	Petroleum Terminals	9	terminals	9	0
	Potential Renewable Energy Sites	13	sites	5	0
Food System Assets and Resources	Food Pantries	9	pantries	3	2
	Public Refrigerated Warehouses	2	sites	1	0
	SNAP Businesses	193	businesses	67	43
Government Facilities	City Property	966	properties	196	0
	Courthouses and Court Systems	9	facilities	3	0
	Major State Government Buildings	38	buildings	1	0
Parks and Open Spaces	Cemeteries	17	cemeteries	5	0
	Community Gardens	5	sites	2	0
	Parks and Playgrounds	143	parks	25	0
Public Housing Resources	HUD Multifamily Properties	27	properties	12	1
	RRHA Housing	60	locations/ parcels	31	0
Public Safety and Emergency Response	Cooling Centers	3	centers	1	0
	Correctional Facilities	3	facilities	2	0
	EMS Stations	24	stations	7	0
	Fire Stations	21	stations	6	0
	National Shelter System Facilities	20	facilities	3	0
	Police Stations	5	Stations	2	0
	Sheriff Facilities	7	facilities	5	0
Stormwater and Sewer Infrastructure	Sewer Treatment Plant	1	plants	1	0
Terrestrial Habitat	James River Features Islands (Islands)	15	islands	5	0
	Terrestrial Habitat	14	habitats/ locations	12	0
Transportation Infrastructure - Bike/Ped	Bike Infrastructure	71.2	miles	6.8	0
	Bikeshare Stations	17	stations	1	0
	Trails	15.94	miles	0.5	0
Transportation Infrastructure - Marine	Marine Transportation	1	unit	1	0
Transportation Infrastructure - Rail and Transit	Public Transit Stations	2	stations	0	2
	Railroad Bridges	27	bridges	7	0
	Rail Lines	159.6	miles	73.7	0

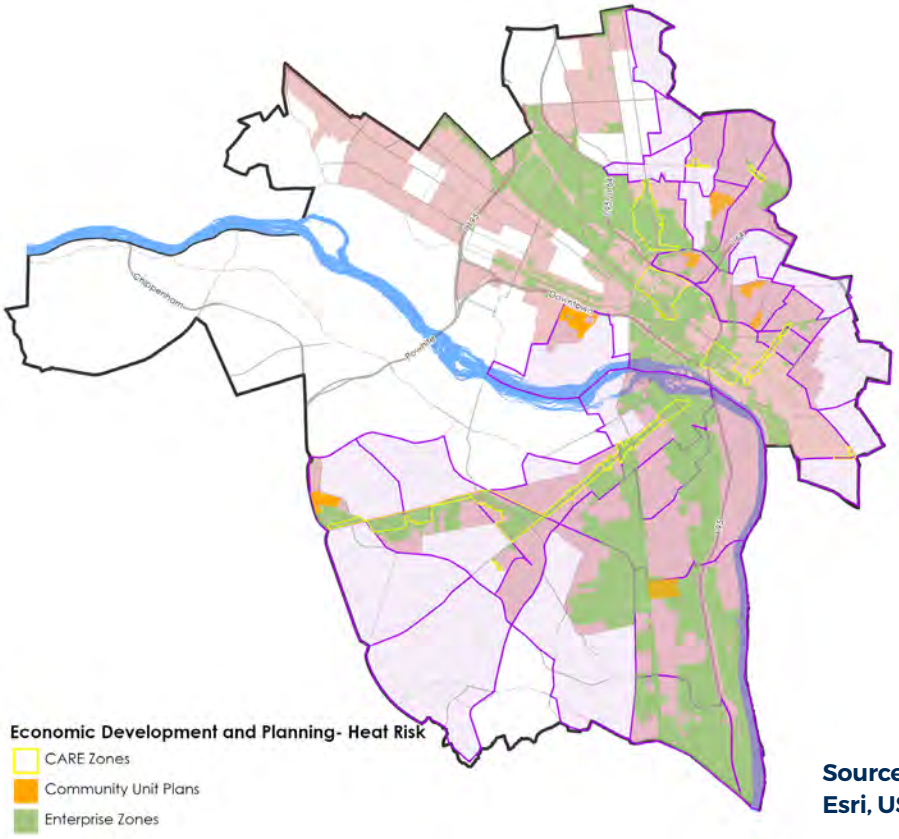
Asset Category	Asset Name	Total City-wide	Units	Heat Risk - Afternoon Mean High Temp >95°	
				Assets at Heat Risk in Highly Socially Vulnerable (SV) Areas	Assets Serving SV Groups at Heat Risk Outside Highly SV Areas
Transportation Infrastructure - Roads and Bridges	Bridges	177	bridges	46	0
	Roads	1,206.7	miles	314.0	0
Trees and Vegetation	Tree canopy (Street Trees and Trees Other)	120,356	trees	25,696	0
Waste Management Infrastructure	EPA Regulated Facilities	79	facilities	52	0
	Solid Waste Landfill Facilities	1	facilities	1	0
Water bodies	Chesapeake Bay Protection Area	13,038.3	acres	3,193.3	0
	Creeks	31	creeks	10	0
	Lakes	100	lakes	28	0



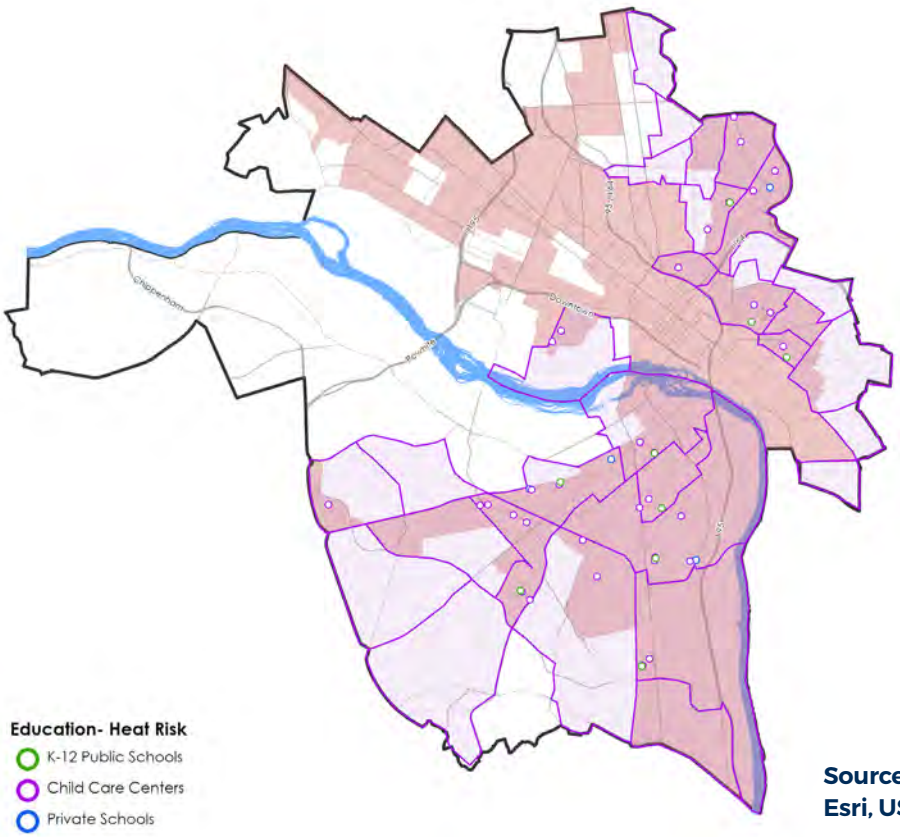
Sources: City of Richmond, Esri, US Census Bureau



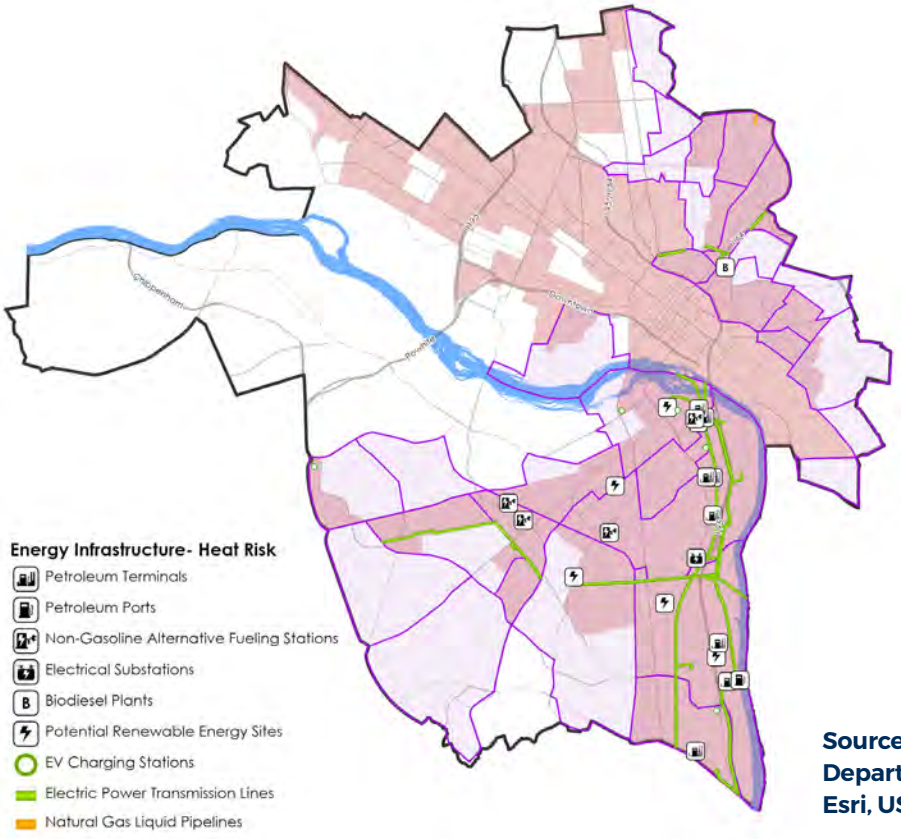
Sources: City of Richmond, Esri, US Census Bureau



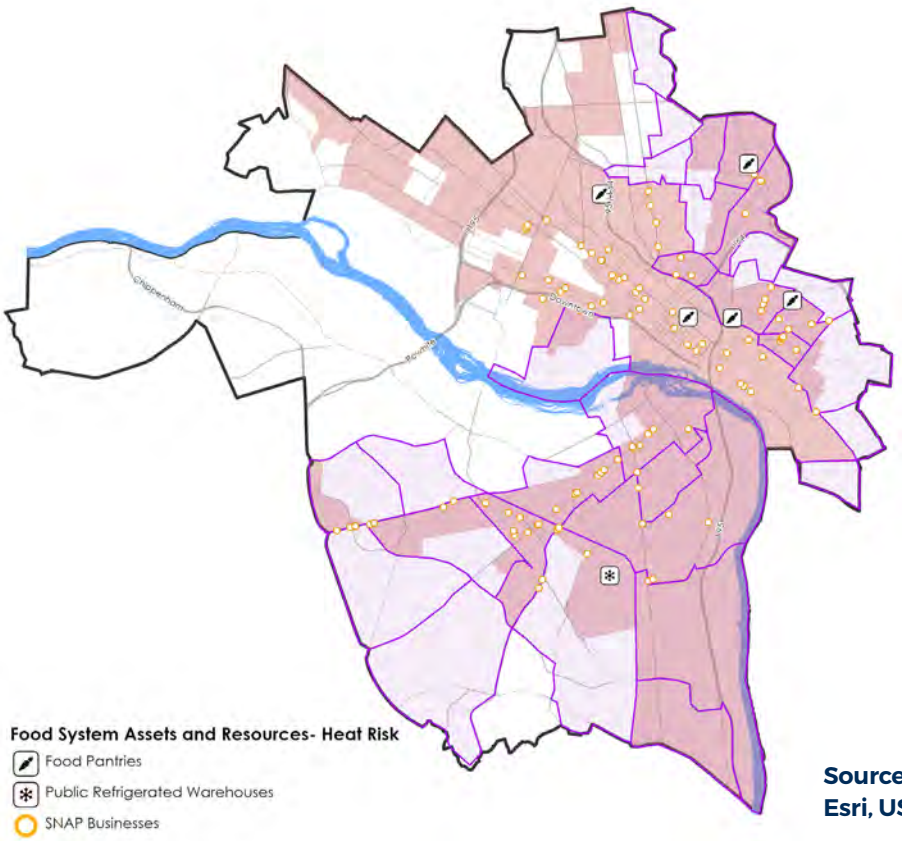
Sources: City of Richmond, Esri, US Census Bureau



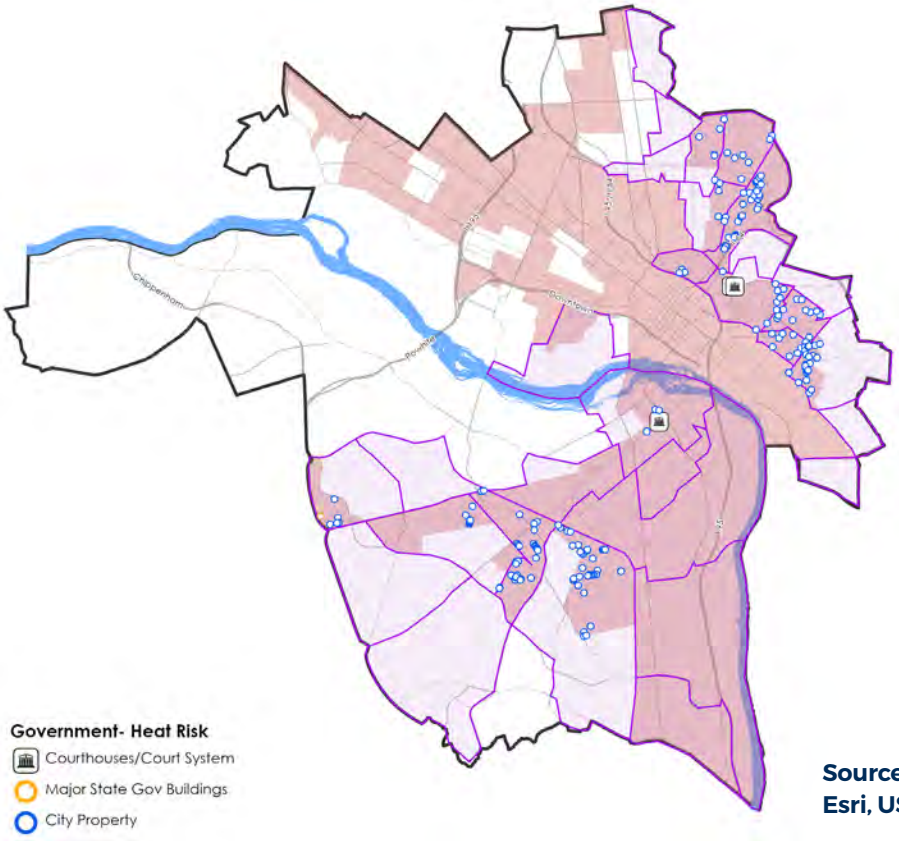
Sources: City of Richmond, Esri, US Census Bureau



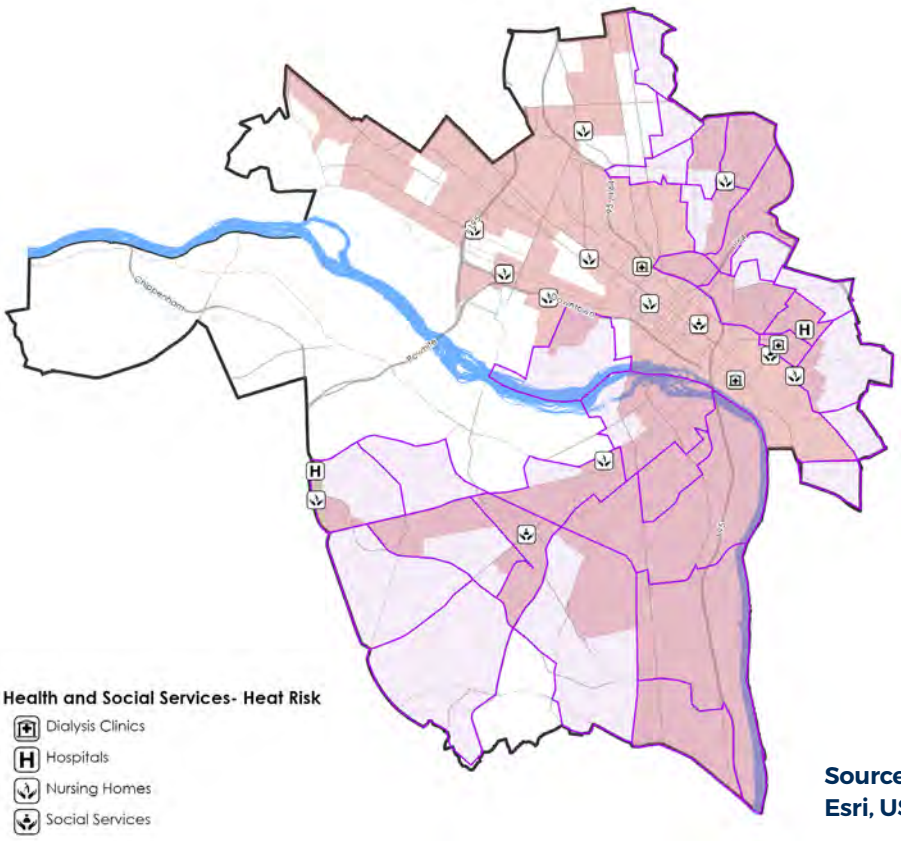
Sources: City of Richmond, Department of Energy, Esri, US Census Bureau



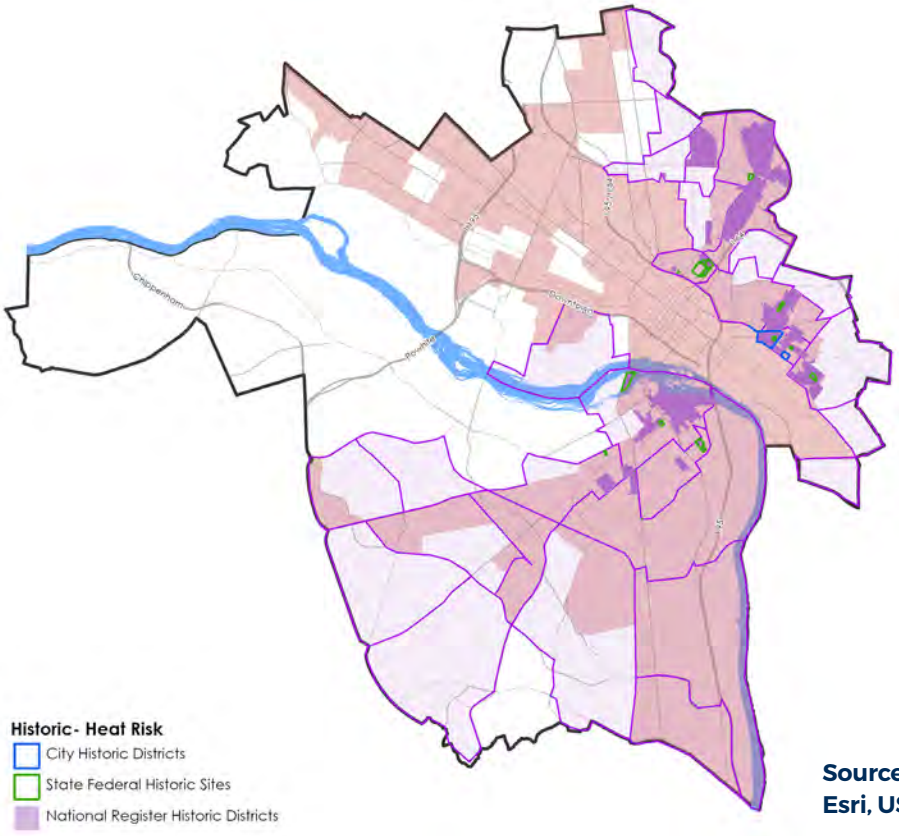
Sources: City of Richmond, Esri, US Census Bureau



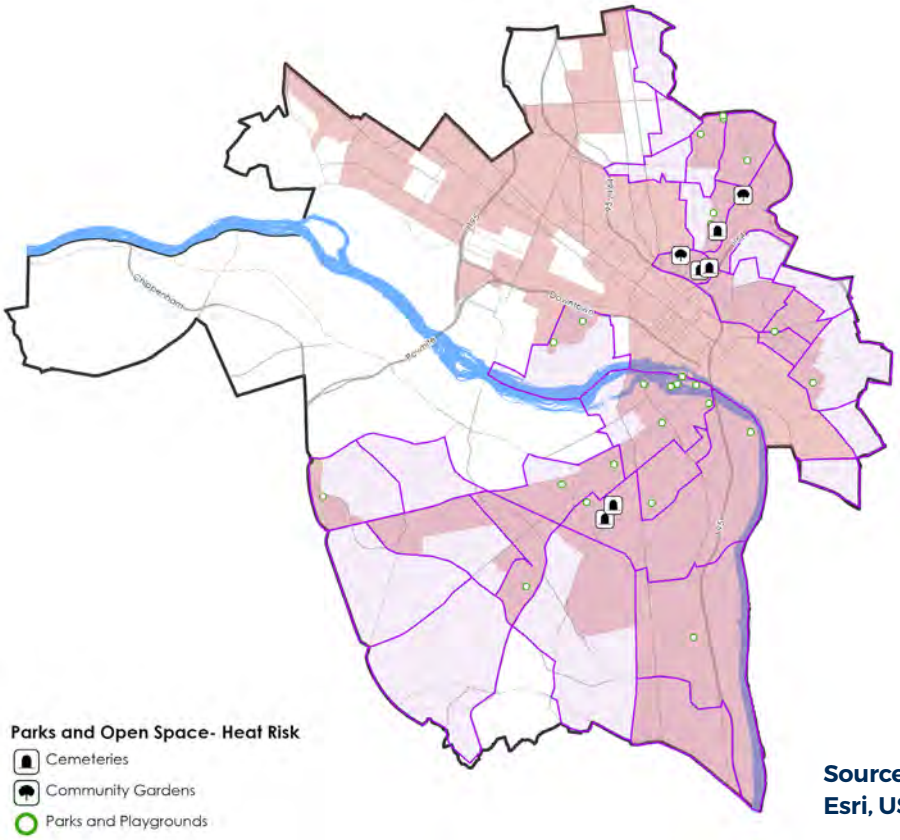
Sources: City of Richmond, Esri, US Census Bureau



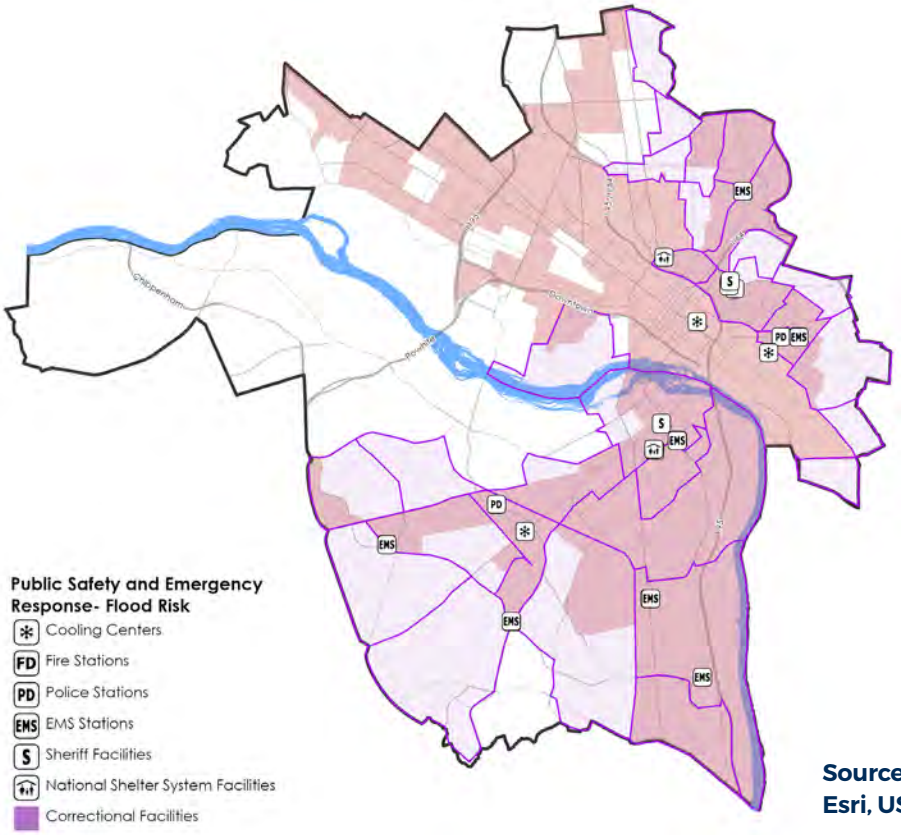
Sources: City of Richmond, Esri, US Census Bureau



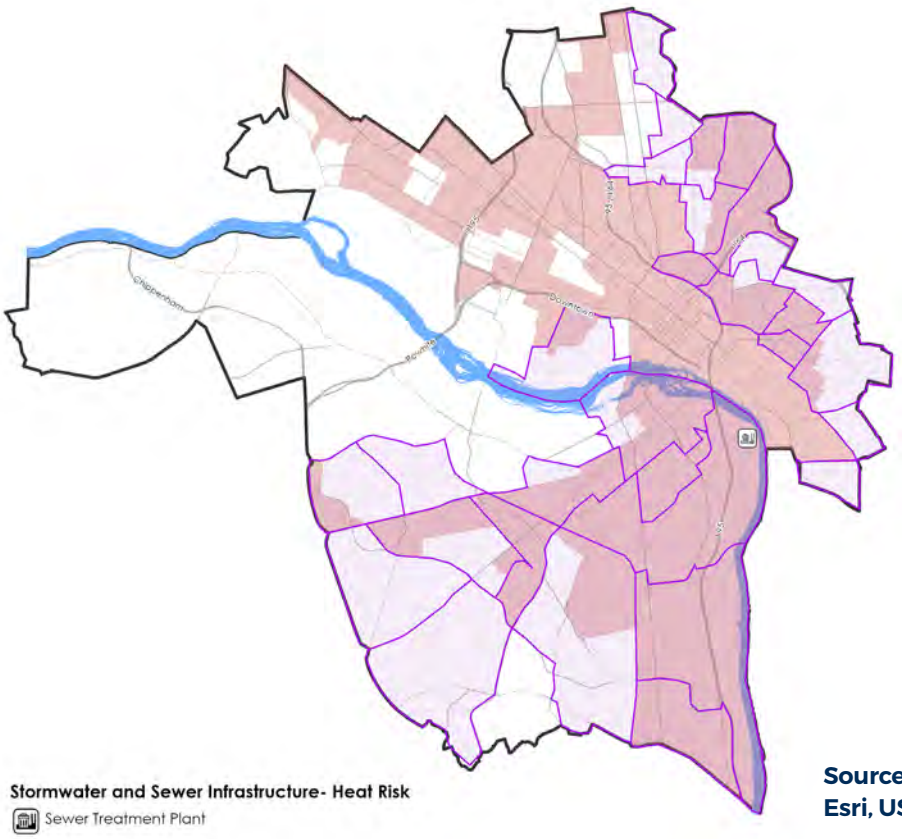
Sources: City of Richmond, Esri, US Census Bureau



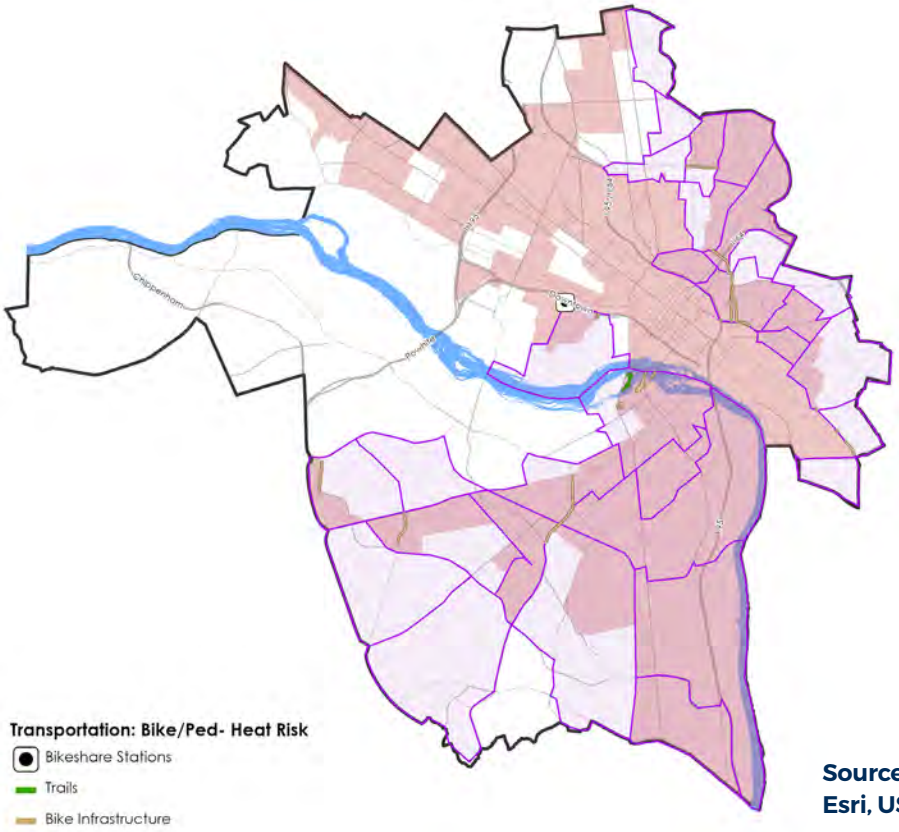
Sources: City of Richmond, Esri, US Census Bureau



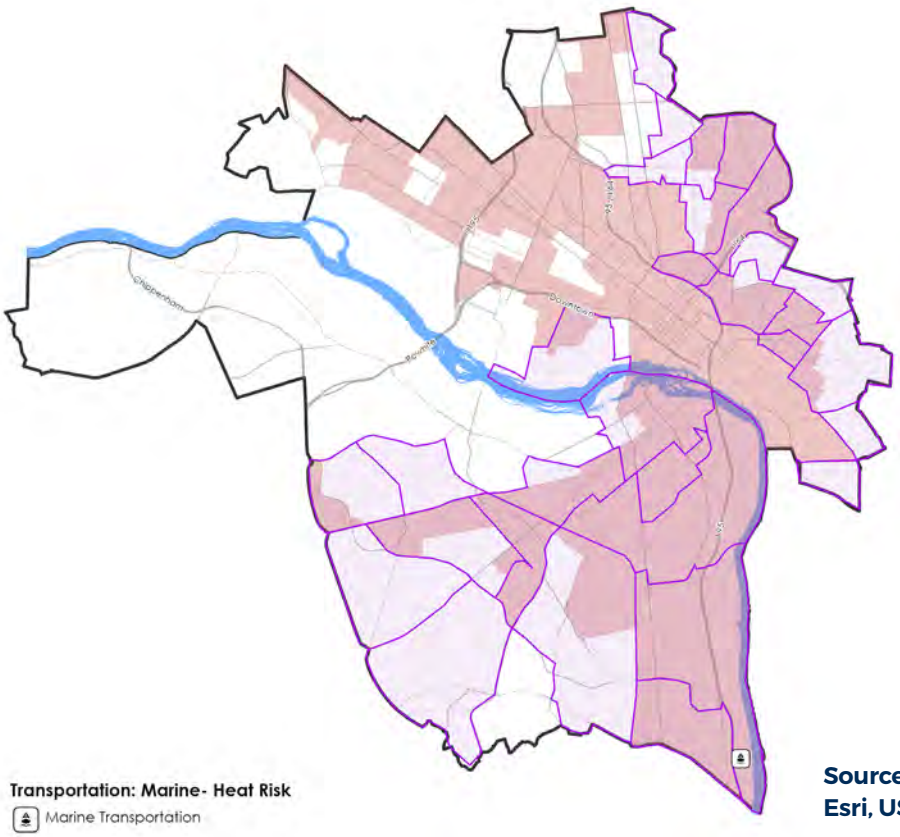
Sources: City of Richmond, Esri, US Census Bureau



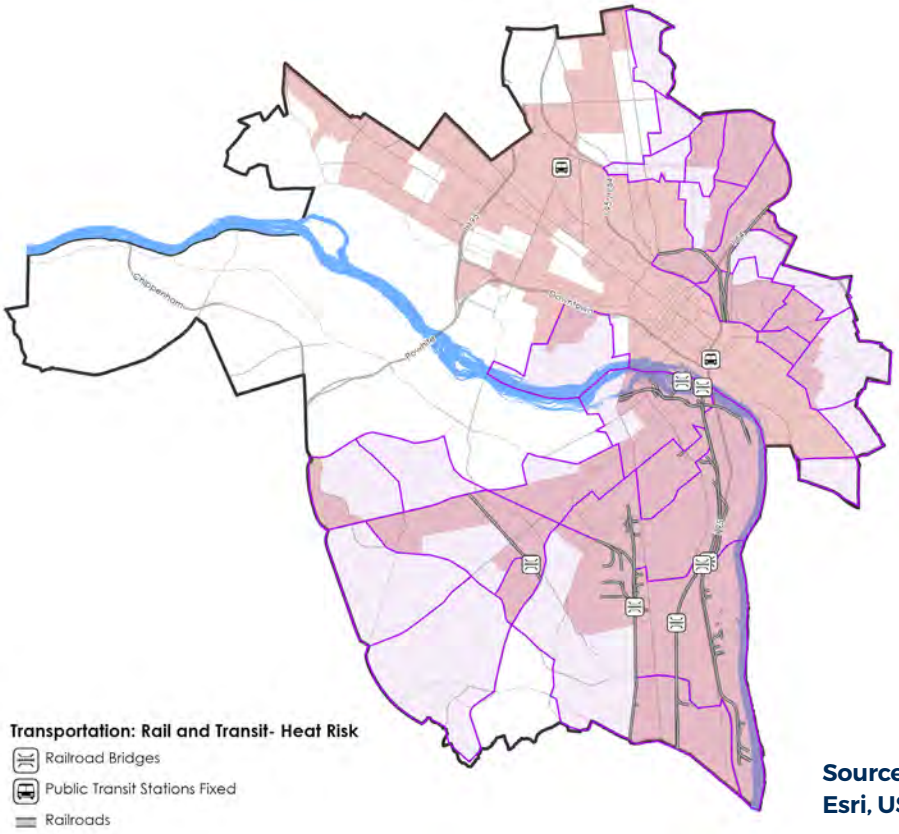
Sources: City of Richmond, Esri, US Census Bureau



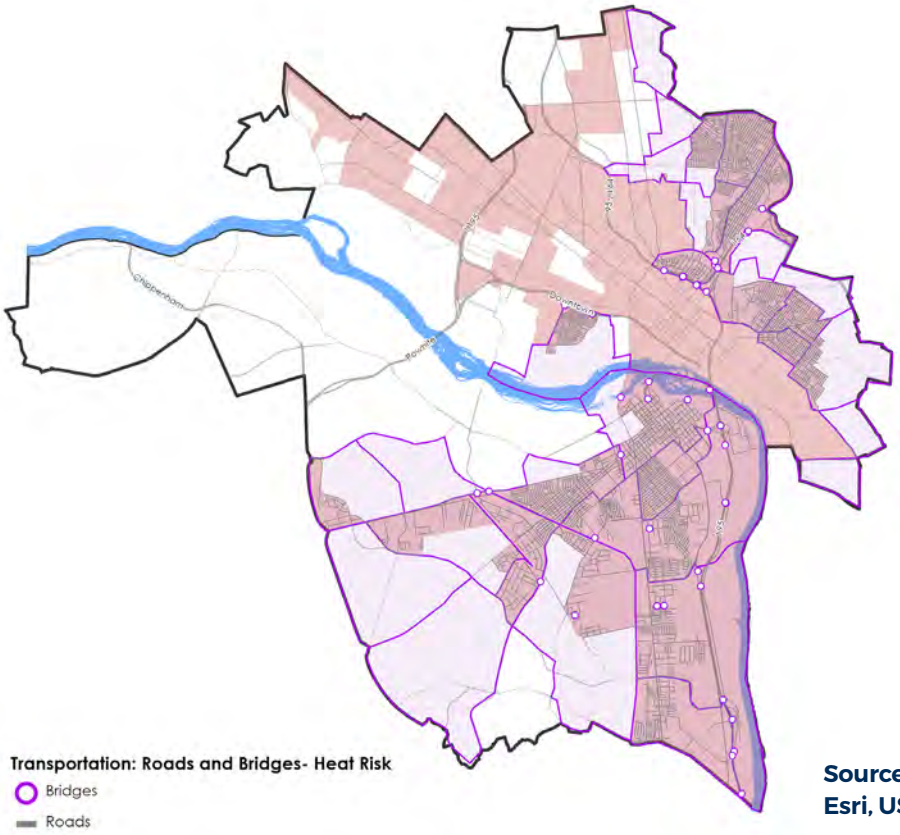
Sources: City of Richmond, Esri, US Census Bureau



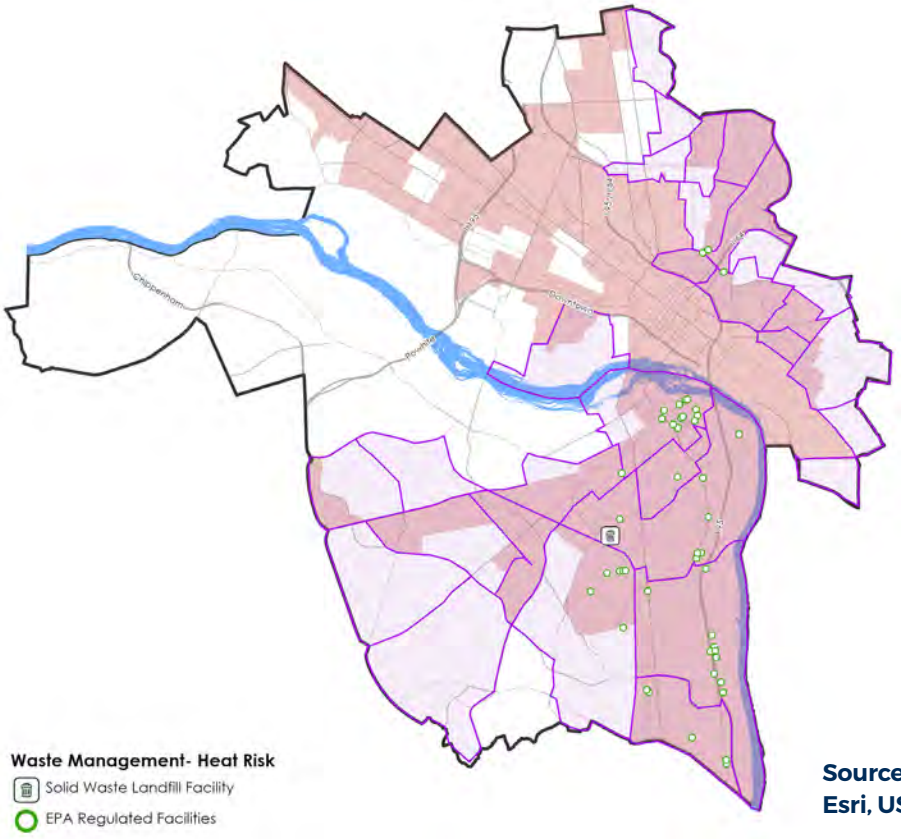
Sources: City of Richmond, Esri, US Census Bureau



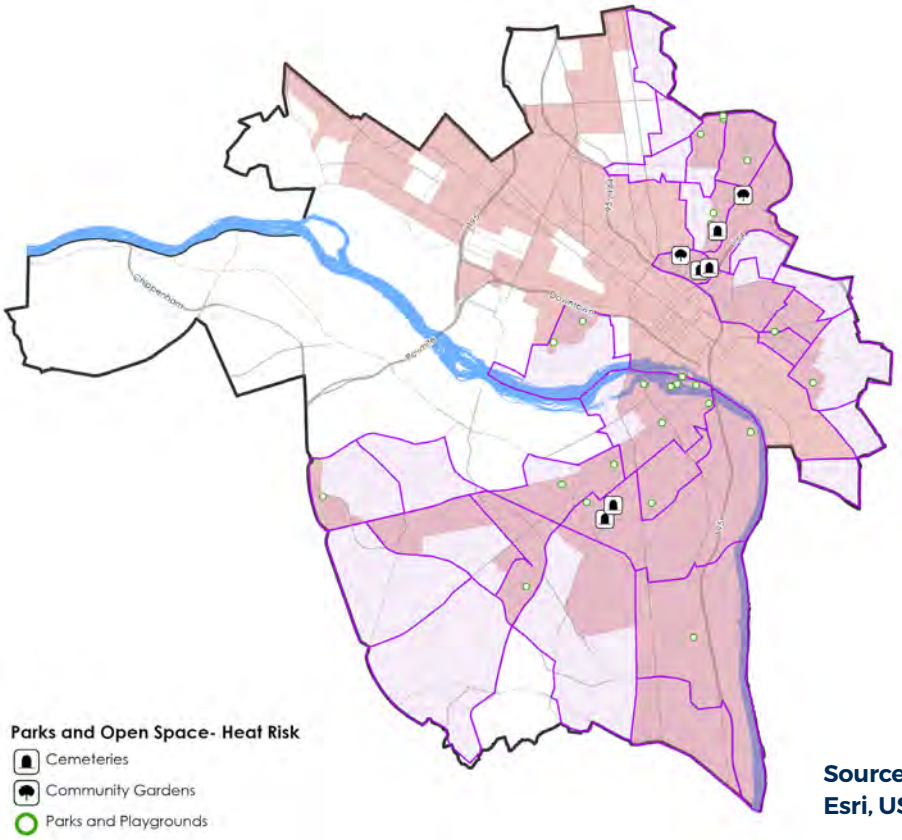
Sources: City of Richmond, Esri, US Census Bureau



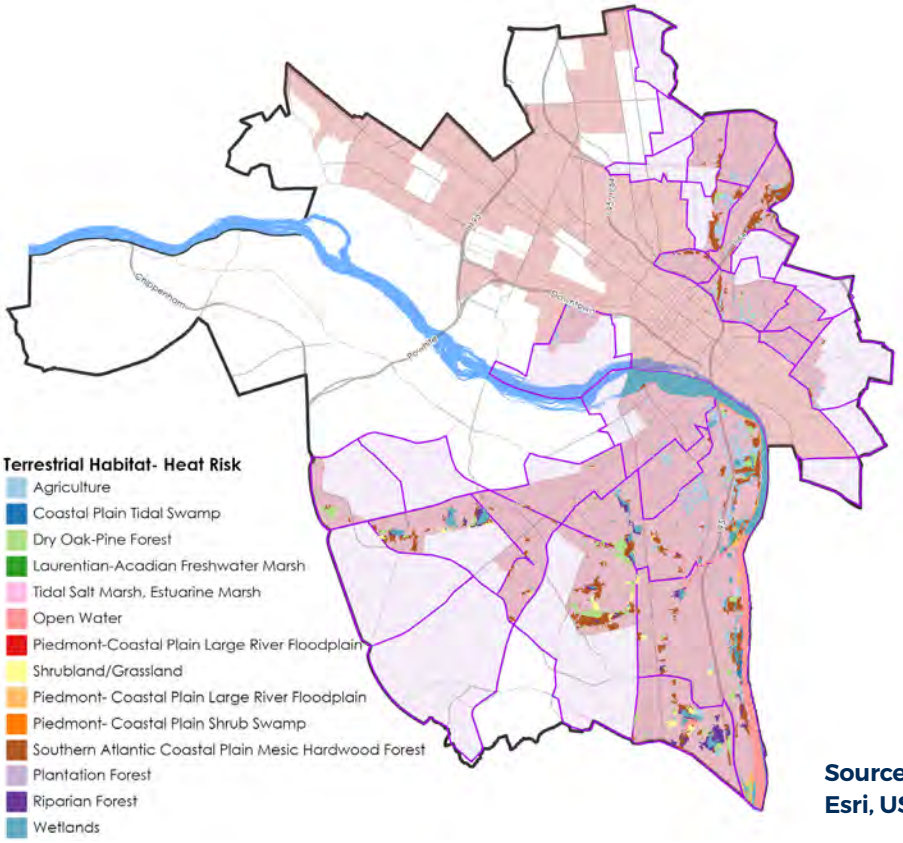
Sources: City of Richmond, Esri, US Census Bureau



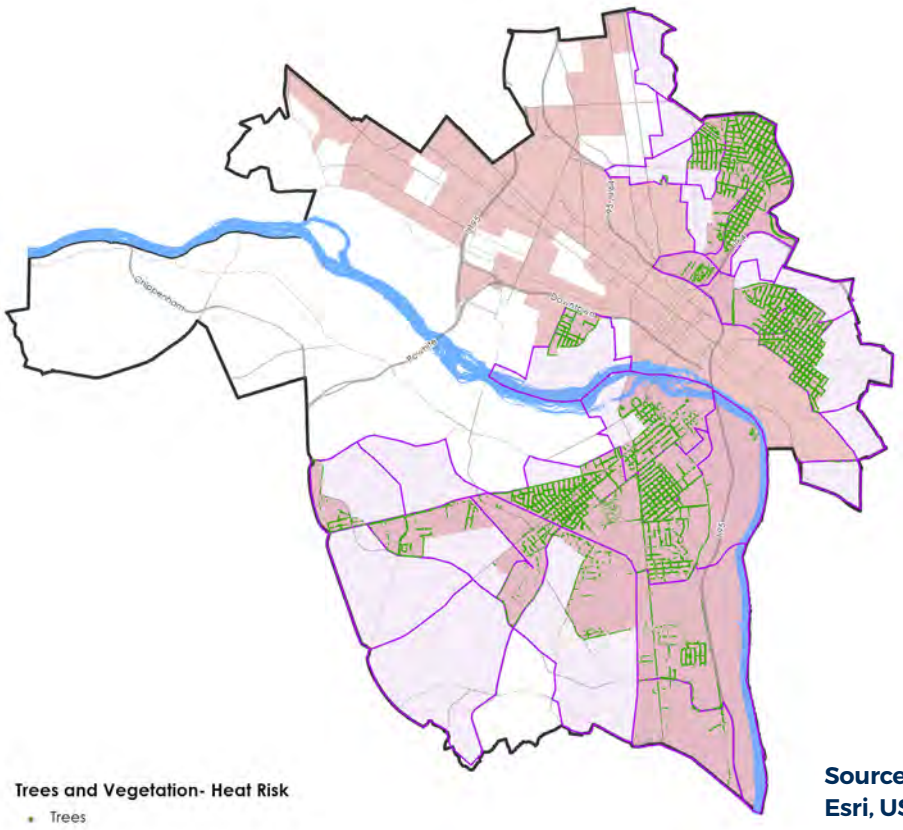
Sources: City of Richmond, Esri, US Census Bureau



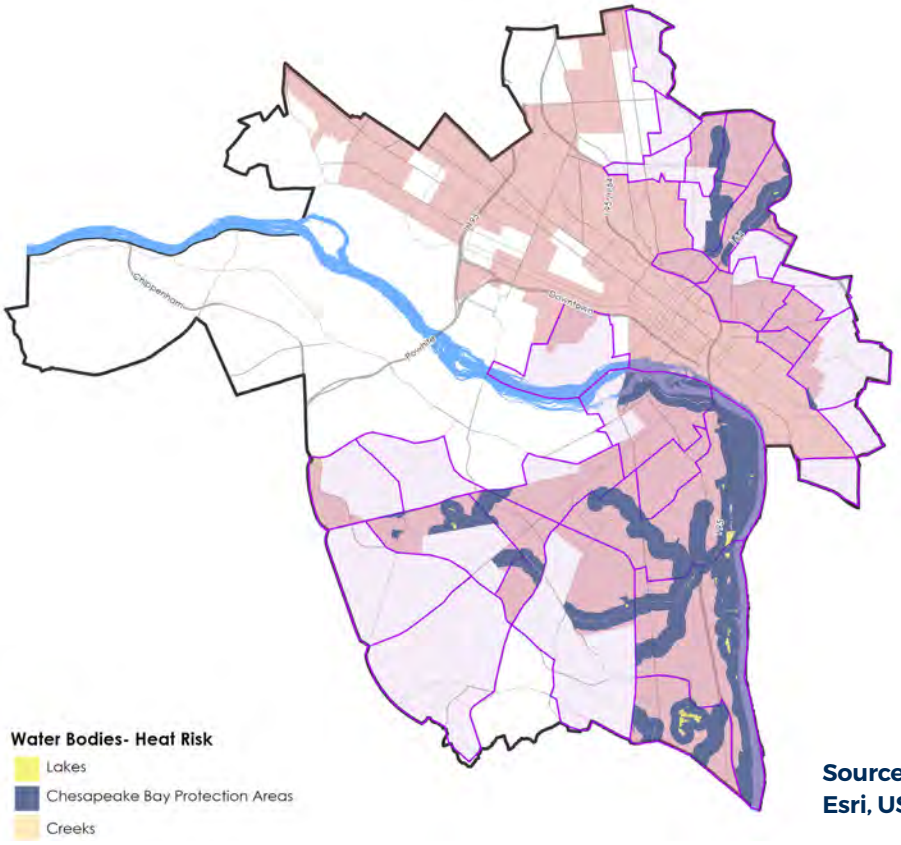
Sources: City of Richmond, Esri, US Census Bureau



Sources: City of Richmond, Esri, US Census Bureau



Sources: City of Richmond, Esri, US Census Bureau



Sources: City of Richmond, Esri, US Census Bureau

6.2 Prioritized Needs – Critical Heat Risk

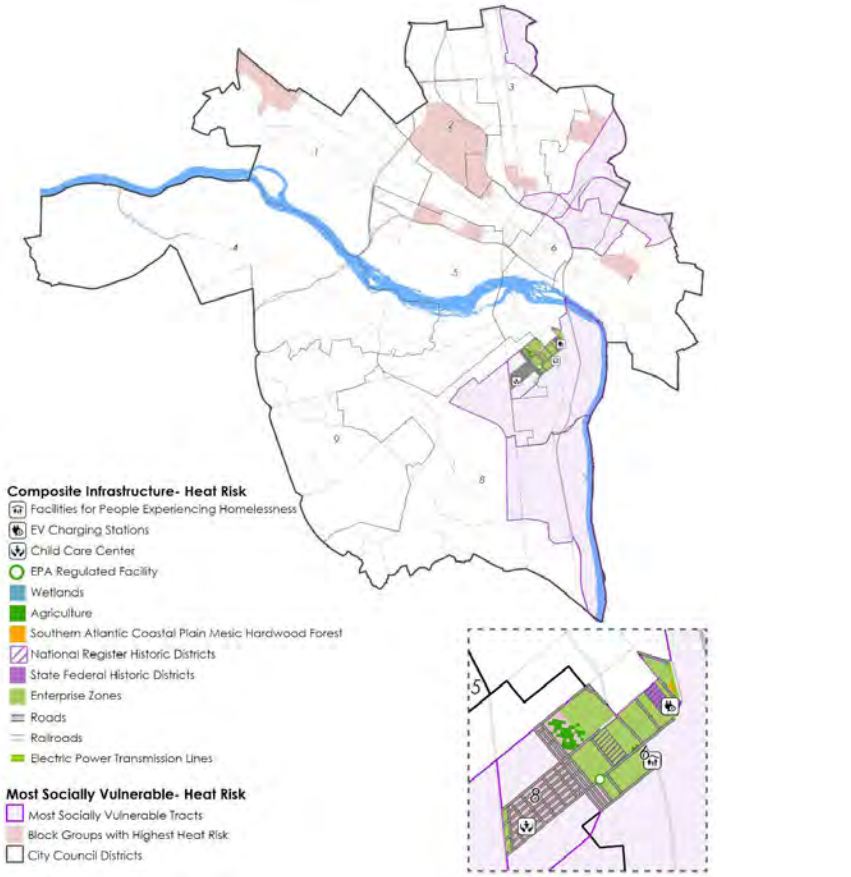
Table 6.2 and the map figure that follows summarize the assets in the "most" socially vulnerable areas or that predominantly or exclusively serve socially vulnerable groups that have exposure to the highest heat risk from climate change (areas with current afternoon mean high temperatures above 96˚F). The name or address of these assets is included along with the stakeholder consequence ranking to support City prioritization of equity-centered climate resilience strategies and action for these critical resources and areas.

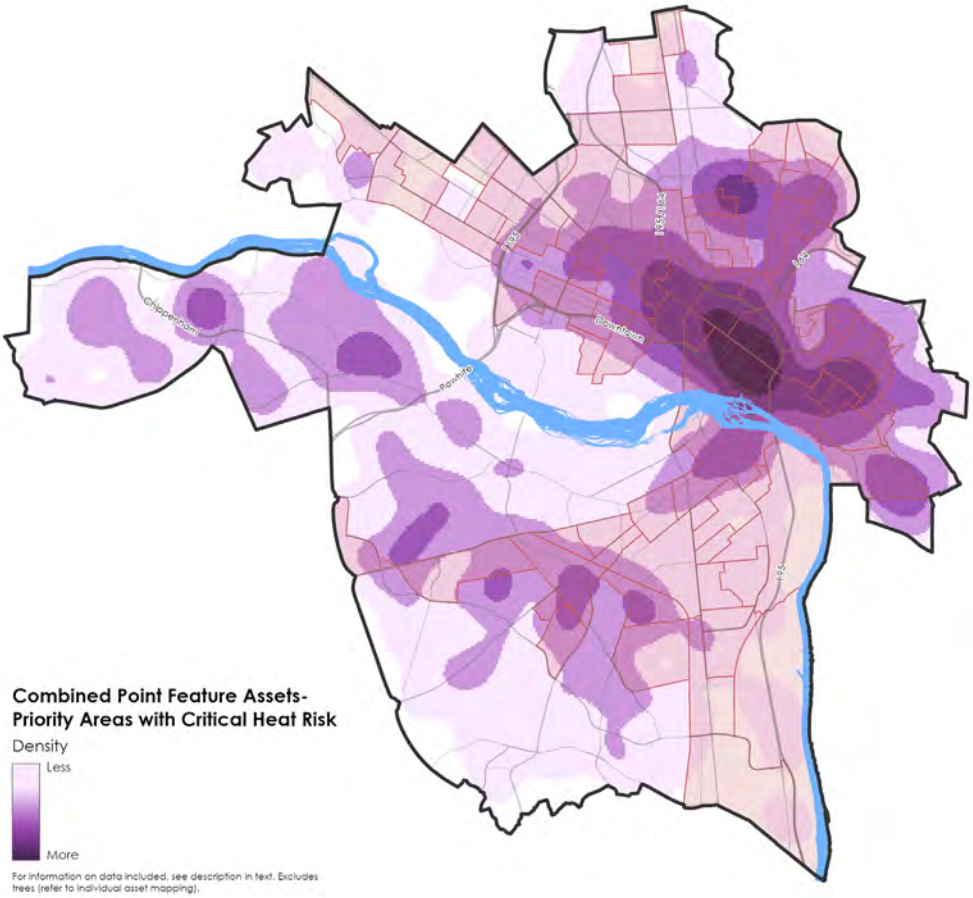
Areas with concentrations of potentially impacted assets independent of social vulnerability are shown in the final map series of heat risk. Density maps are presented for potentially impacted assets represented as: point features (such as various types of community, education, government, health, and safety facilities and buildings, housing, communications towers, bridges, and other infrastructure); linear features (such as bike infrastructure, power transmission lines, railroads, and trails); and zonal or area features (such as economic development zones, historic districts, and natural habitats and preservation areas).

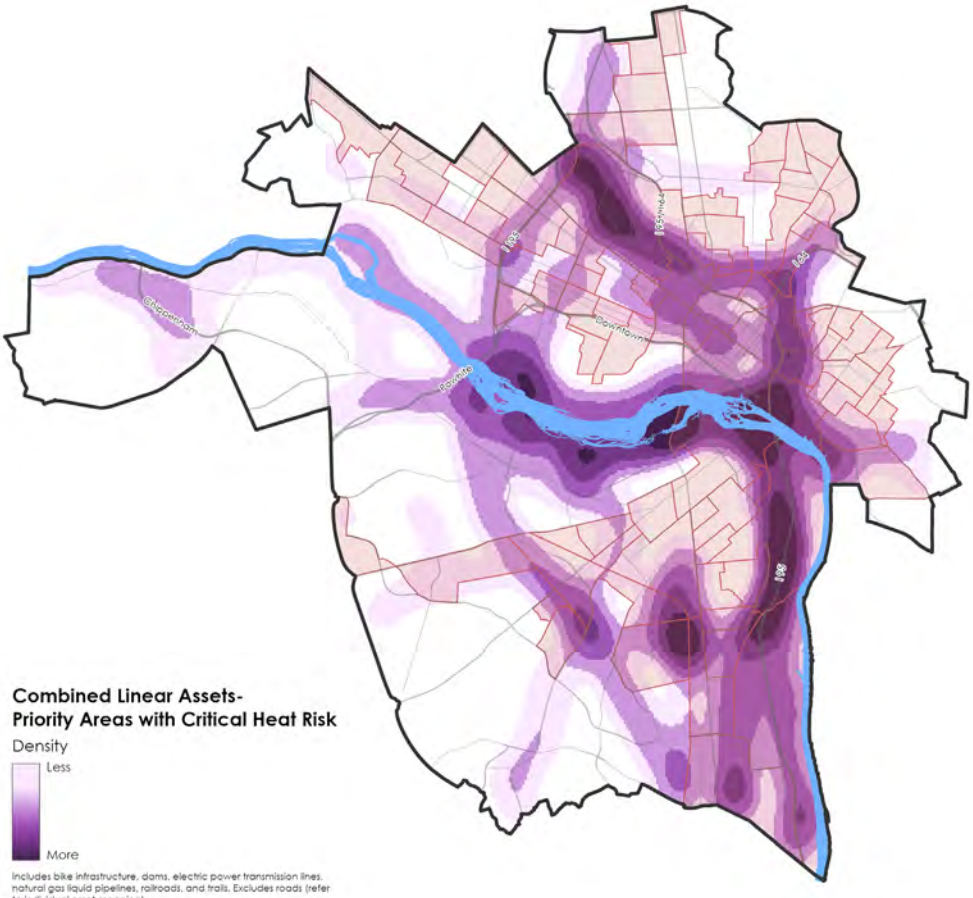
Table 6.2 Prioritized Needs - Critical Heat Risk

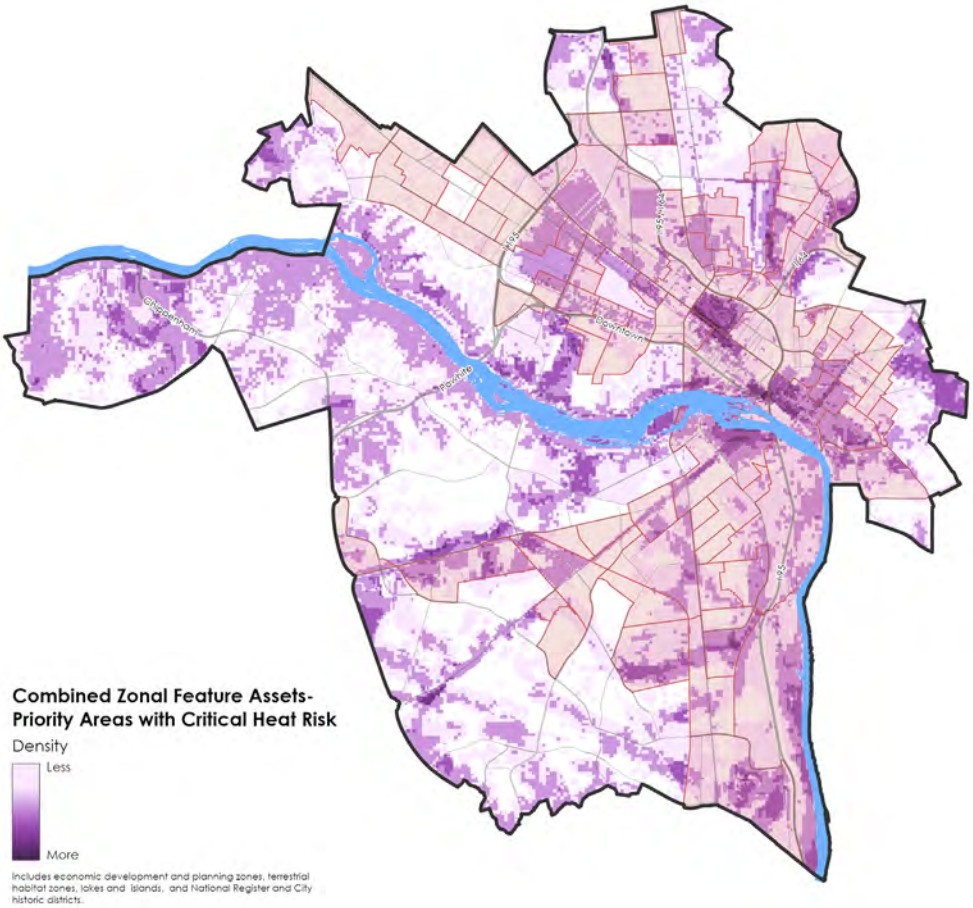
Asset Category	Asset Name	Assets at Highest Heat Risk in Most Socially Vulnerable Areas	Assets Serving SV Groups at Highest Heat Risk Outside Most SV Areas	Units	Critical Heat Risk - Afternoon Mean High Temp >96*	
					Assets/locations exposed to Critical Heak Risk (Above 96*)	Conse-quence
Education	Childcare Centers	1	0	centers	Oak Grove Child Care Center - 2200 Fairfax Avenue Richmond VA 23224	
Health and Social Services	Dialysis Clinics	0	1	clinics	*DaVita Richmond Community Dialysis - 913 North 25th Street Richmond VA 23233	
	Homeless Facilities	1	1	facilities	Caritas - 1125 Commerce Road Richmond VA 23224, *Pilgrims Passage - 1500 Sherwood Road Richmond VA 23220	
	Nursing Homes	0	1	homes	*Brook Haven Rest Home - 610 Fourqurean Lane	
Historic	National Register Historic Districts	4	0	Districts	Union Hill; Southern Stove Works; Chesapeake Warehouses; Highland Park Plaza	
	State Federal Historic Sites	1	0	sites	Southern Stove Works Manchester	
Economic Development and Planning	CARE Zones	1	2	zones	*Lombardy/Chamberlayne, *North 25th Street, Meadowbridge	
	Enterprise Zones	2	0	zones	III (2746.8 acre), 1(3611.2 acre)	
Energy Infrastructure	Electric Power Transmission Lines	0.4		miles	See map for locations	
	Electric Vehicle Charging Stations	2	0.0	stations	See map for locations	Not Rated
Food System Assets and Resources	Food Pantries	0	2	pantries	*Northside Outreach Center - 3096 Meadowbridge Road Richmond VA 23222, *Sara and Steve Bayard Community Kitchen - 1415 Rhoadmiller Street Richmond VA 23220	
	SNAP Businesses	0	19	businesses	See map for locations	
Public Housing Resources	HUD Multifamily Properties	0	1	properties	*Highland Park Senior Apartments - 1221 E Brookland Park Blvd, Richmond, VA 23222	
Terrestrial Habitat	Terrestrial Habitat	2	0	habitats/ locations	Agriculture; Southern Atlantic Coastal Plain Mesic Hardwood Forest	
Transportation Infrastructure - Rail and Transit	Public Transit Stations	0	1	stations	*Greyhound Bus Station - 2910 N Boulevard Richmond VA 23230	
	Rail Lines	0.6	0.0	miles	See map for locations	
Transportation Infrastructure - Roads and Bridges	Roads	9.9	0.0	miles	See map for locations	
Trees and Vegetation	Tree canopy (Street Trees and Trees Other)	1,022	0	trees	See map for areas	
Waste Management Infrastructure	EPA Regulated Facilities	1	0	facilities	Southern Printing Ink	

Consequence Scale				
Low	Medium-Low	Medium	Medium-High	Low


Composite Infrastructure- Heat Risk
Facilities for People Experiencing Homelessness
EV Charging Stations
Child Care Center
EPA Regulated Facility
Wetlands
Agriculture
Southern Atlantic Coastal Plain Mesic Hardwood Forest
National Register Historic Districts
State Federal Historic Districts
Enterprise Zones
Roads
Railroads
Electric Power Transmission Lines
Most Socially Vulnerable- Heat Risk
Most Socially Vulnerable Tracts
Block Groups with Highest Heat Risk
City Council Districts


Combined Point Feature Assets-
Priority Areas with Critical Heat Risk
Density
Less
More
For information on data included, see description in text. Excludes trees (refer to individual asset mapping).


Combined Linear Assets-
Priority Areas with Critical Heat Risk
Density
Less
More
Includes bike infrastructure, dams, electric power transmission lines, natural gas liquid pipelines, railroads, and trails. Excludes roads (refer to individual asset mapping)


Combined Zonal Feature Assets-
Priority Areas with Critical Heat Risk
Density
Less
More
Includes economic development and planning zones, terrestrial habitat zones, lakes and islands, and National Register and City historic districts.

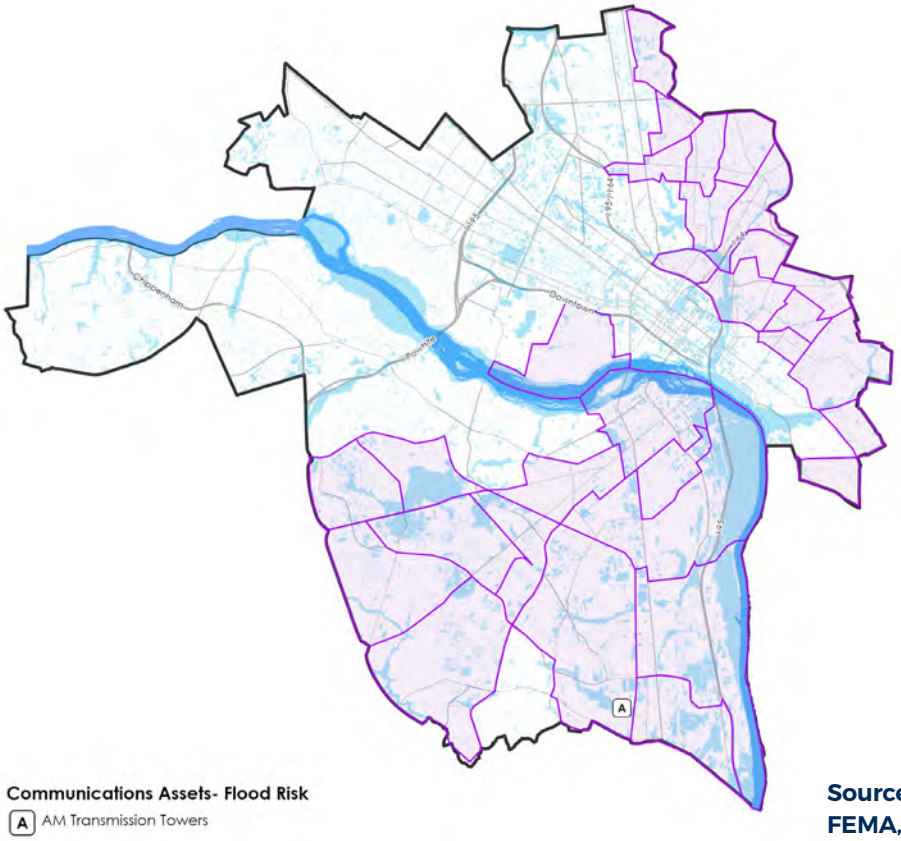
6.3 Prioritized Needs – Flooding Risk

Table 6.3 summarizes the assets in socially vulnerable areas or that predominantly or exclusively serve socially vulnerable groups regardless of location that have exposure to flooding risk from climate change (in the 100-year floodplain and/or in locations that may experience greater than 5 inches of flooding inundation from precipitation events). The map figures on the pages that follow illustrate the location of assets with exposure to flooding risk for each category or grouping of assets of similar types.

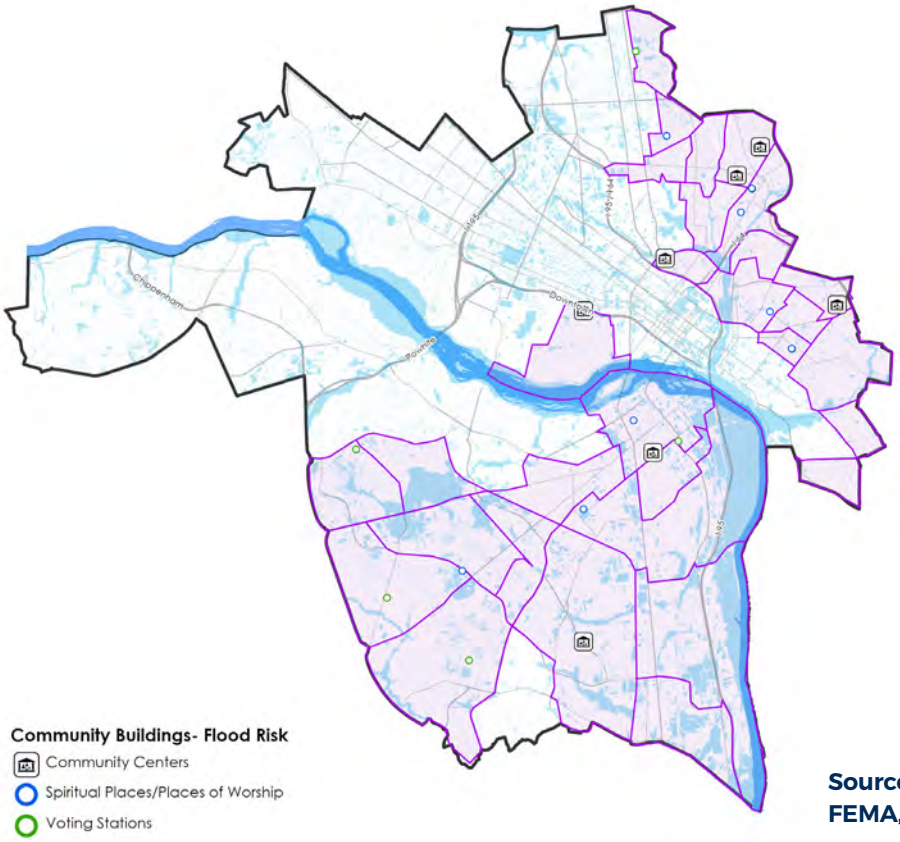
Table 6.3 - Priority Planning Areas - Flood Risk

Asset Category	Asset Name	Total City	Units	Critical Flood Risk	
				Assets at Risk	Resources
Communications Infrastructure	AM Transmission Towers	3	towers	1	0
Community Buildings	Community Centers	22	centers	7	0
	Religious Centers	74	Centers	9	0
	Voting Stations	67	stations	12	0
Economic Development and Planning	CARE Zones	13	zones	11	2
	Community Unit Plans	110	plans	30	0
	Enterprise Zones	4	zones	4	0
	Fortune 500 Corporate Headquarters	1	sites	1	0
Education	Childcare Centers	118	centers	15	0
	K12 Public Schools	44	schools	7	0
	Private Schools	34	schools	3	0
Energy Infrastructure	Biodiesel Plants	1	facilities	1	0
	Electric Power Transmission Lines	53.7	miles	21.8	0.0
	Electric Vehicle Charging Stations	134	stations	5	
	Non Gasoline Alternative Fueling Stations	13	stations	2	0
	Petroleum Ports	1	ports	1	0
	Petroleum Terminals	9	terminals	8	0
	Potential Renewable Energy Sites	13	sites	1	0
Food System Assets and Resources	SNAP Businesses	193	businesses	8	3
Government Facilities	City Property	966	properties	62	0
Health and Social Services	Homeless Facilities	5	facilities	0	1
	Hospitals	6	hospitals	3	0
	Nursing Homes	17	homes	2	8
	Social Services	3	services	0	1
Historic	City Historic Districts	45	districts	3	0
	National Register Historic Districts	133	Districts	32	0
	State Federal Historic Sites	156	sites	17	0
Parks and Open Spaces	Parks and Playgrounds	143	parks	14	0
Public Housing Resources	HUD Multifamily Properties	27	properties	1	1
	RRHA Housing	60	locations/ parcels	40	2
Public Safety and Emergency Response	Cooling Centers	3	centers	0	1
	Correctional Facilities	3	facilities	2	1
	EMS Stations	24	stations	4	0
	Fire Stations	21	stations	3	0
	National Shelter System Facilities	20	facilities	5	0
	Police Stations	5	Stations	1	0
	Sheriff Facilities	7	facilities	4	0

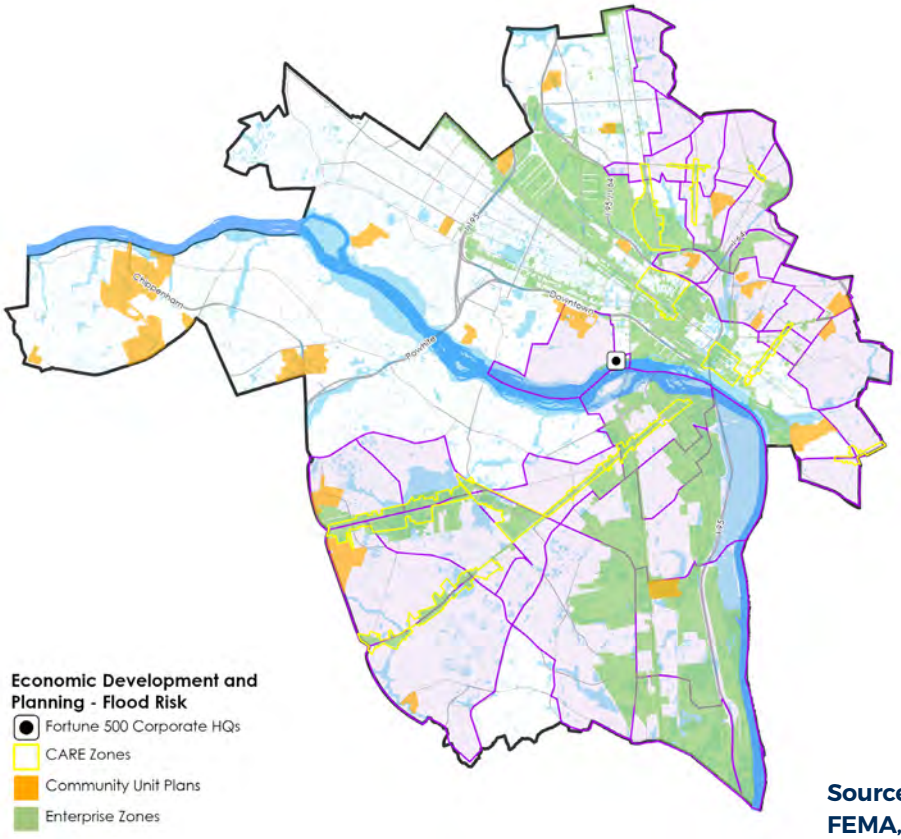
Asset Category	Asset Name	Total City	Units	Critical Flood Risk	
				Assets at Risk	Resources
Stormwater and Sewer Infrastructure	Active StormwaterOutfall	1,658	units	492	0
	Sewer Treatment Plant	1	plants	1	0
Terrestrial Habitat	James River Features Islands (Islands)	15	islands	8	0
	Terrestrial Habitat	14	habitats/ locations	13	0
Transportation Infrastructure - Bike/ Ped	Bike Infrastructure	71.2	miles	3.1	0.0
	Trails	15.94	miles	2.1	0.0
Transportation Infrastructure - Marine	Marine Transportation	1	unit	1	0
Transportation Infrastructure - Rail and Transit	Public Transit Stations	2	stations	0	2
	Railroad Bridges	27	bridges	7	0
	Rail Lines	159.6	miles	18.7	0.0
Transportation Infrastructure - Roads and Bridges	Bridges	177	bridges	27	0
	Roads	1,206.7	miles	43.8	0.0
Trees and Vegetation	Tree canopy (Street Trees and Trees Other)	120,356	trees	3,556	0
Waste Management Infrastructure	EPA Regulated Facilities	79	facilities	10	0
Water bodies	Chesapeake Bay Protection Area	13,038.3	acres	1,964.8	0.0
	Creeks	31	creeks	17	0
	Lakes	100	lakes	39	0



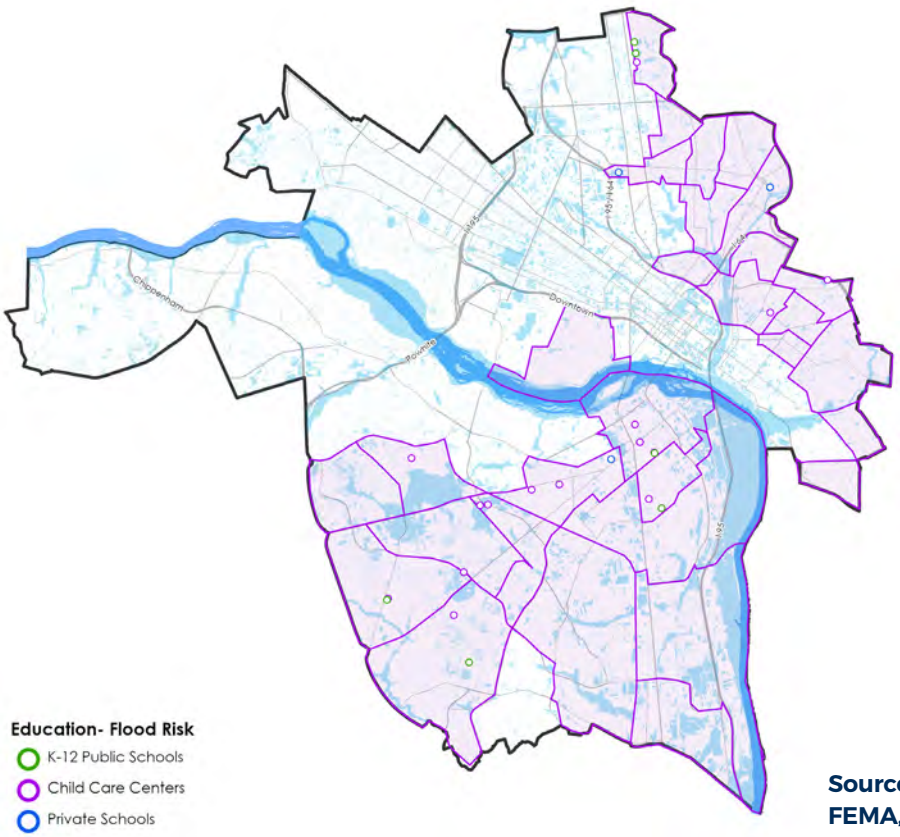
Sources: City of Richmond, Esri, FEMA, US Census Bureau



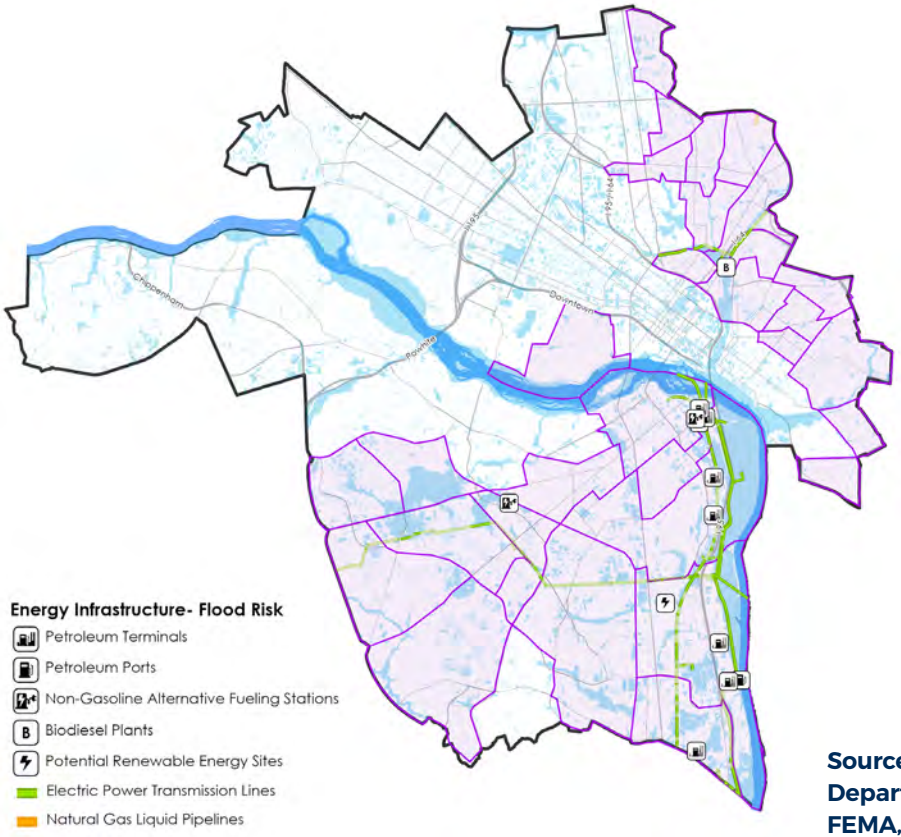
Sources: City of Richmond, Esri, FEMA, US Census Bureau



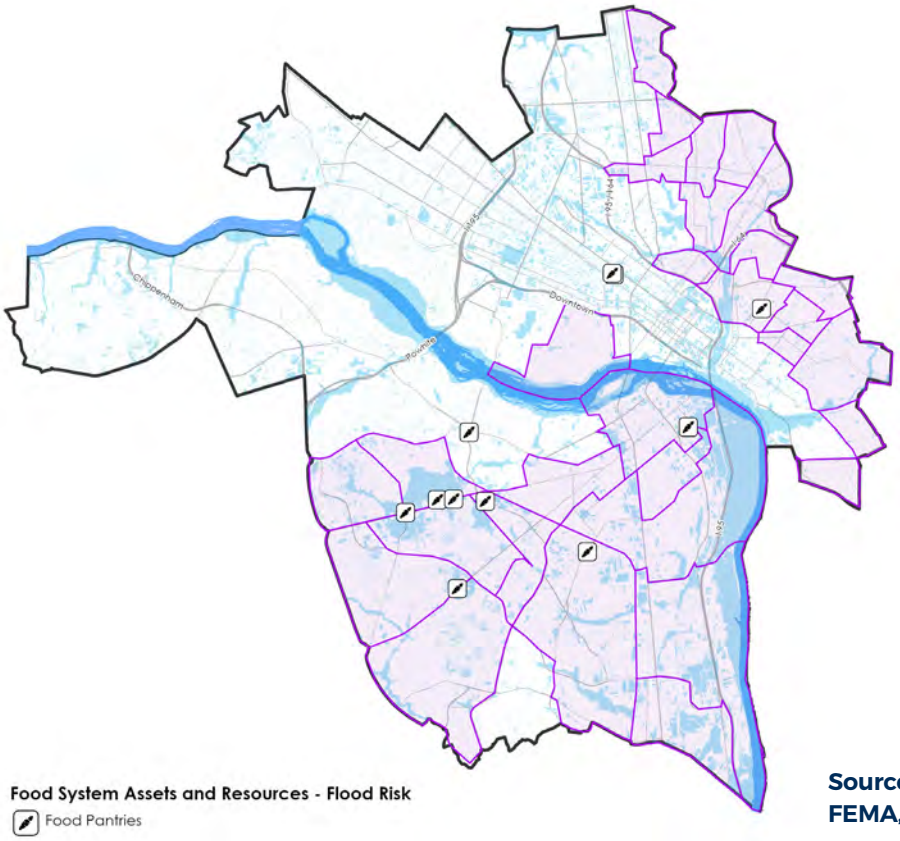
Sources: City of Richmond, Esri, FEMA, US Census Bureau



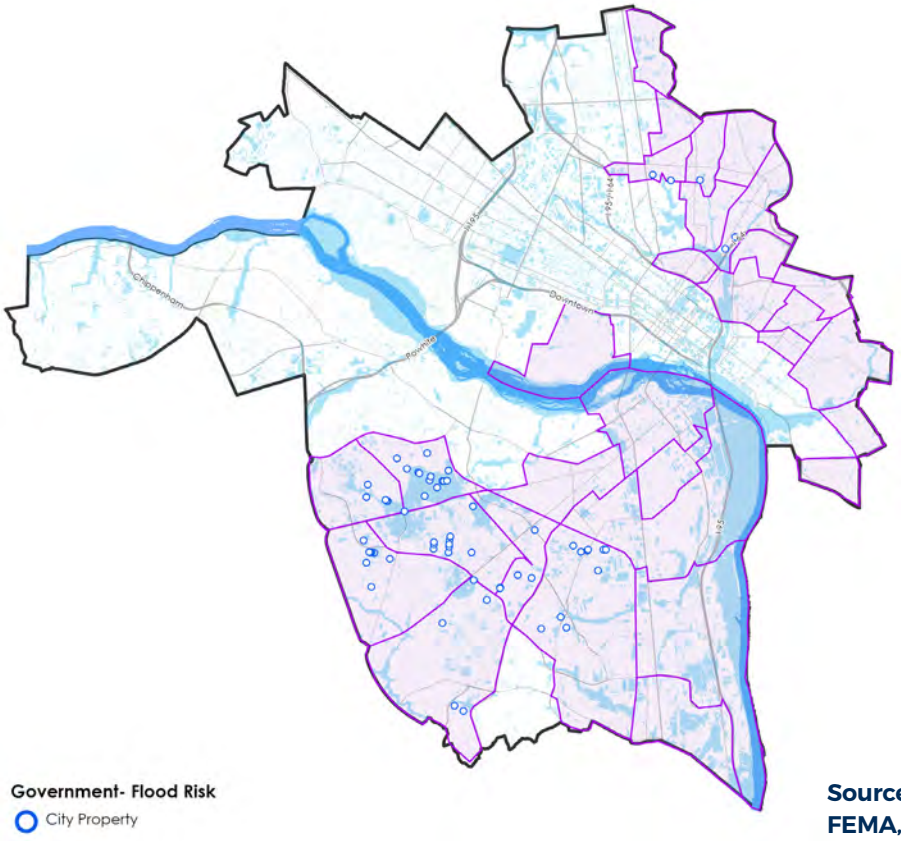
Sources: City of Richmond, Esri, FEMA, US Census Bureau



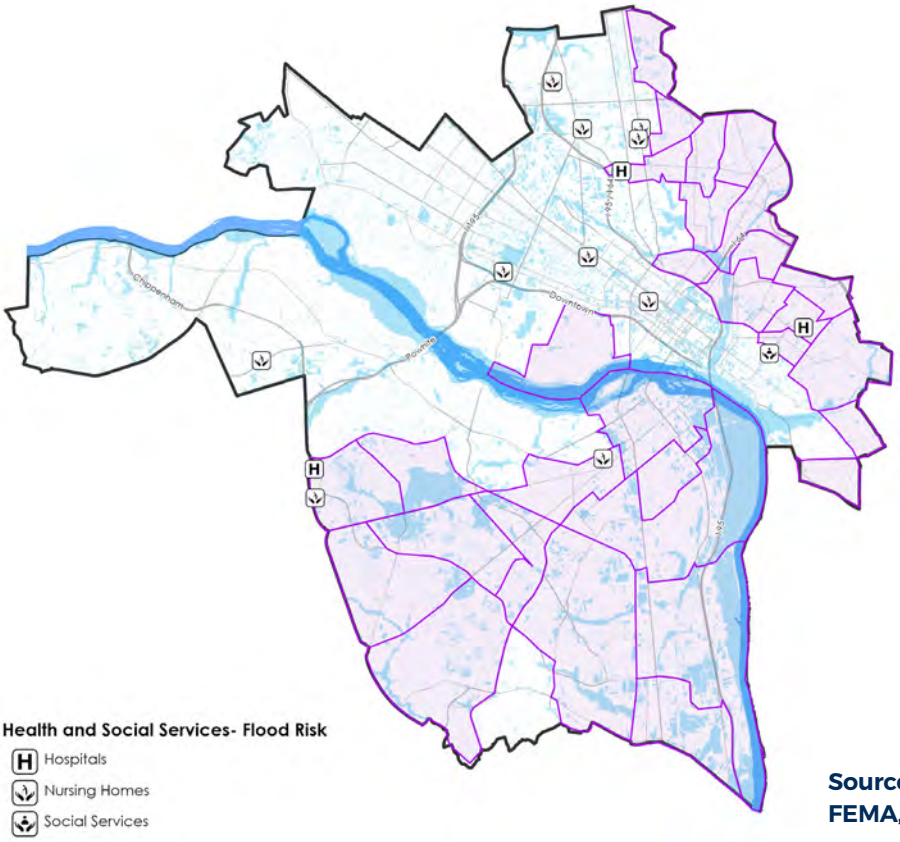
Sources: City of Richmond, Department of Energy Esri, FEMA, US Census Bureau



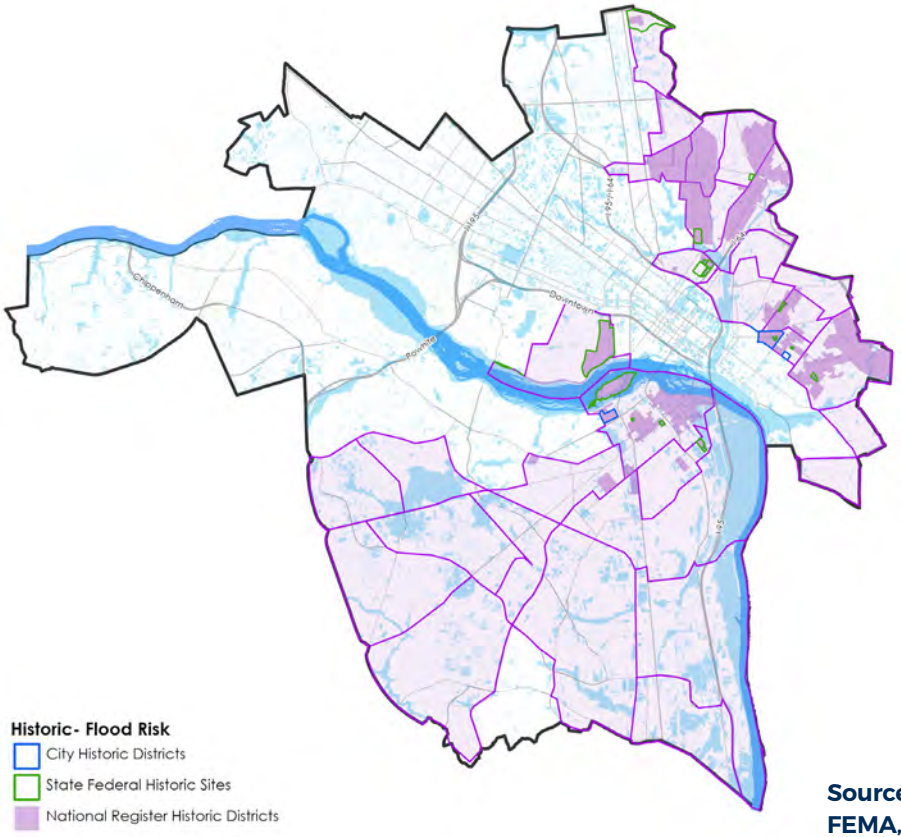
Sources: City of Richmond, Esri, FEMA, US Census Bureau



Sources: City of Richmond, Esri, FEMA, US Census Bureau



Sources: City of Richmond, Esri, FEMA, US Census Bureau



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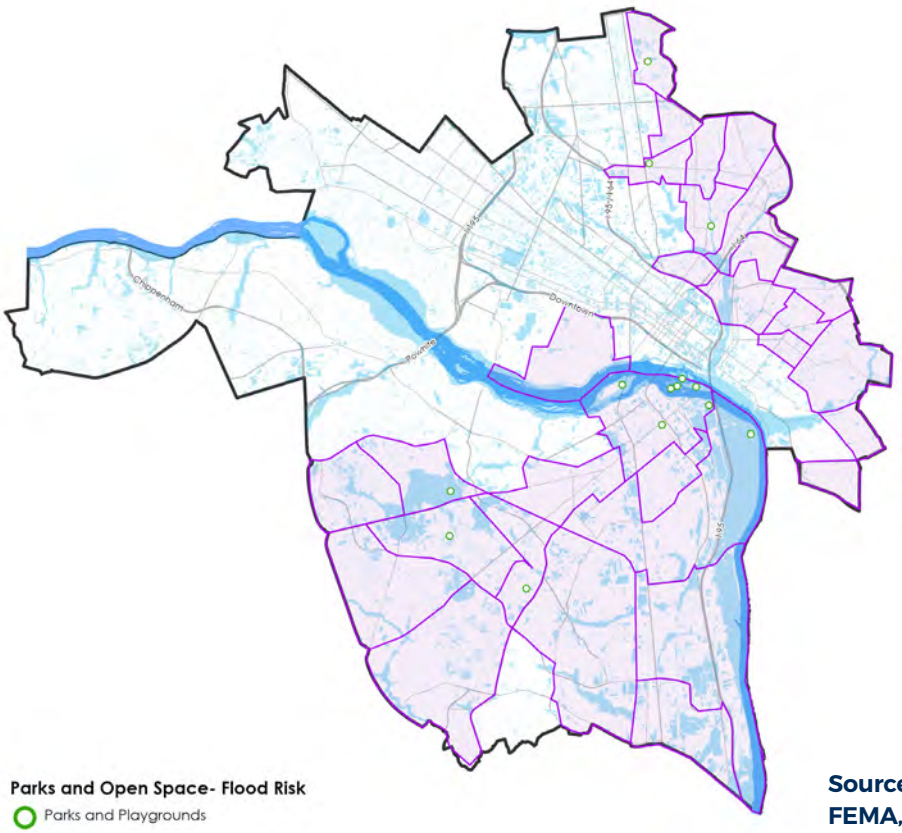

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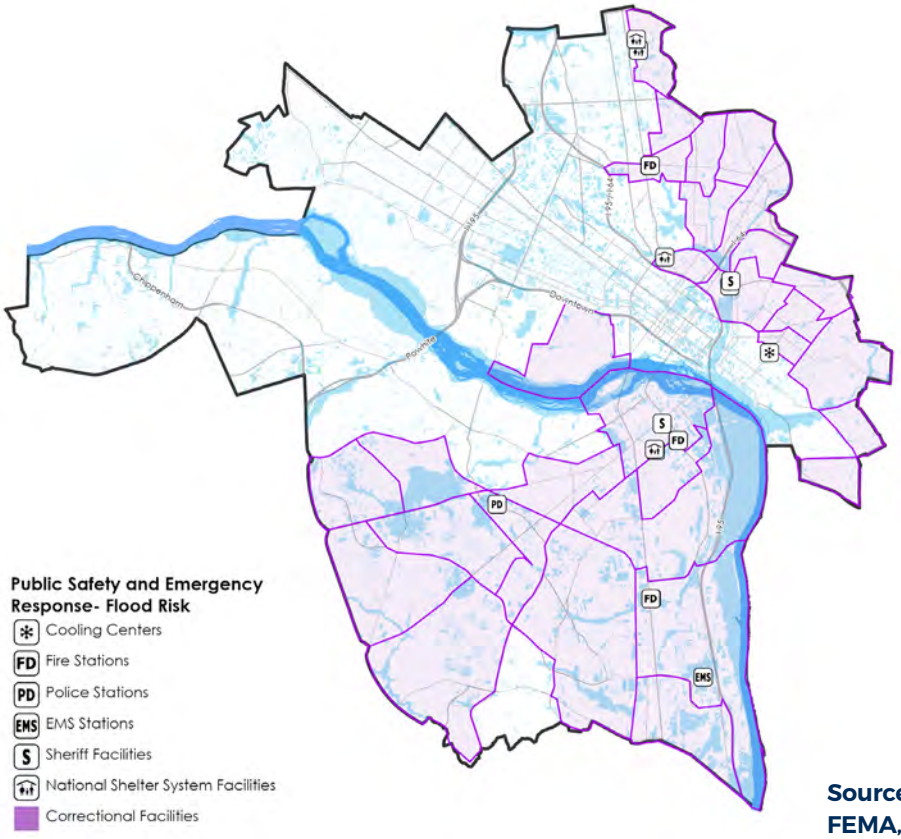

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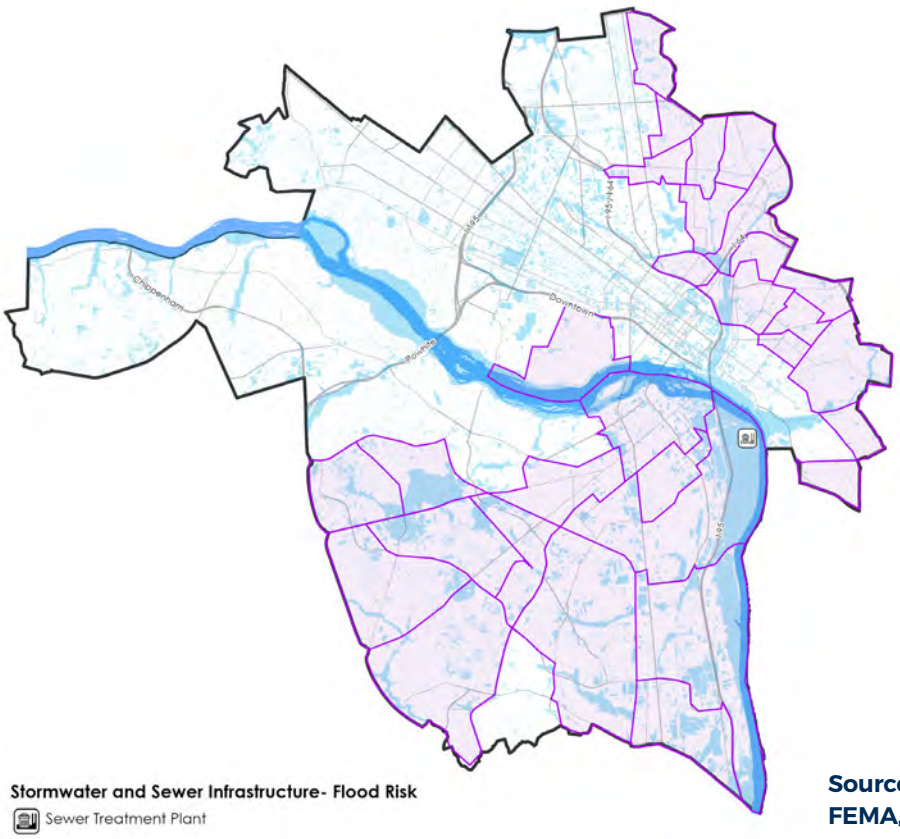

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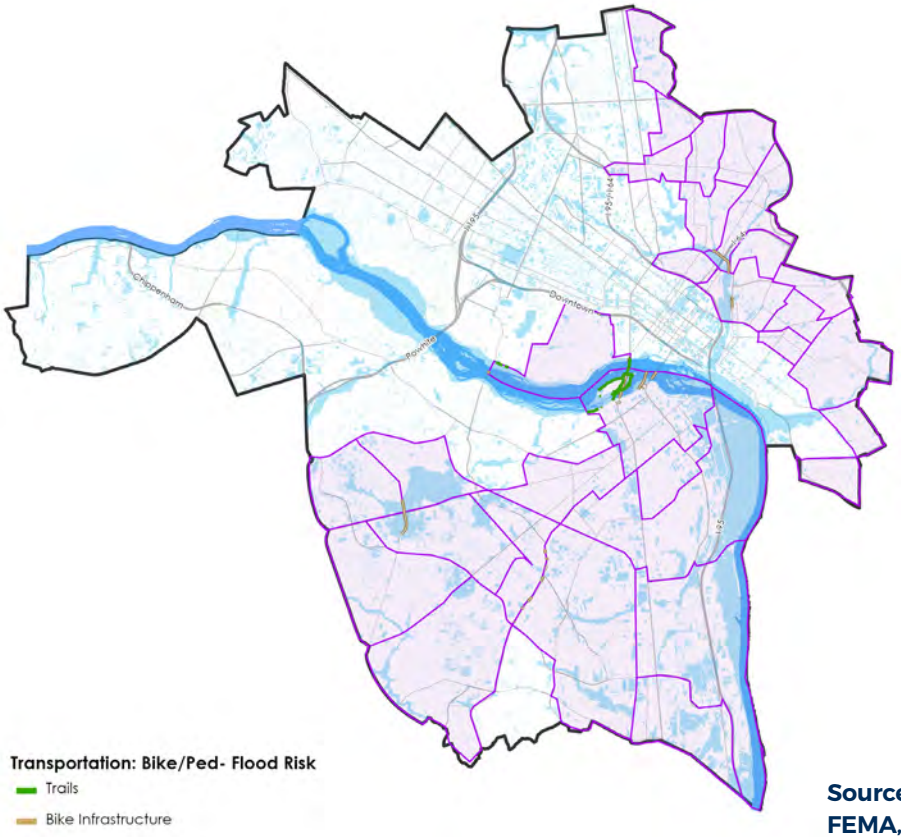

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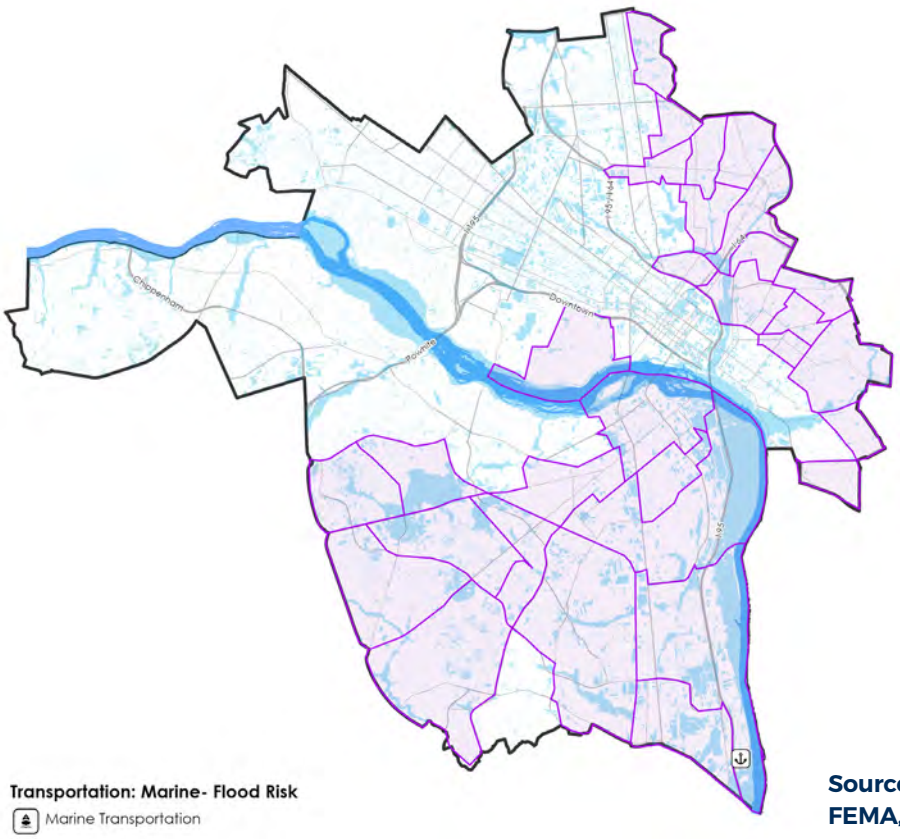

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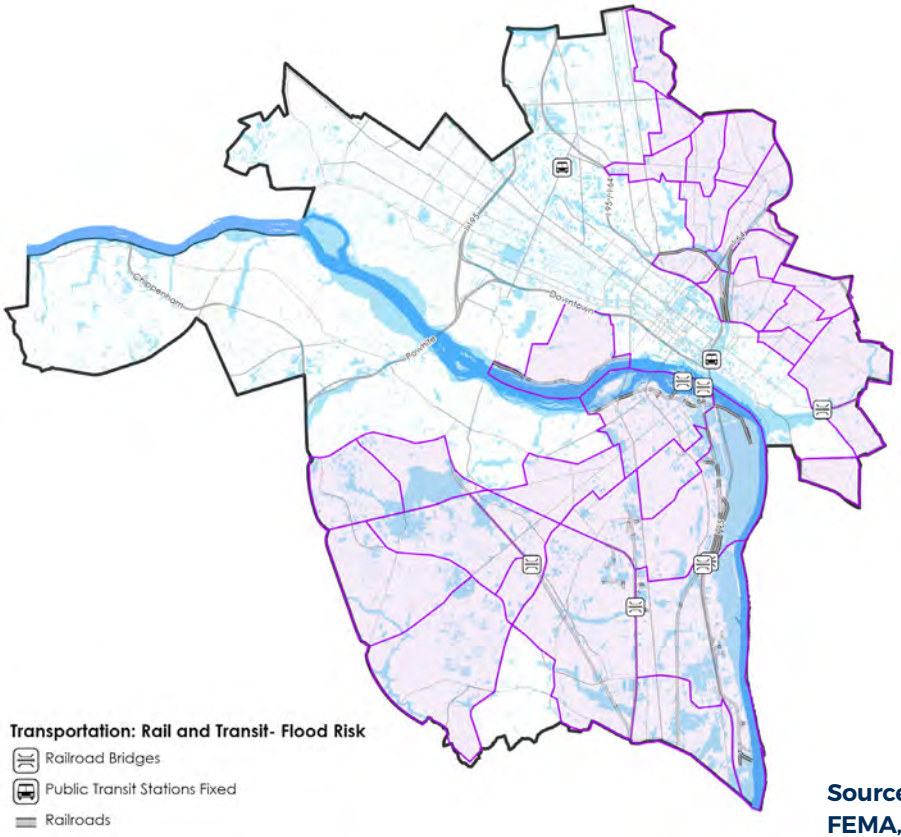

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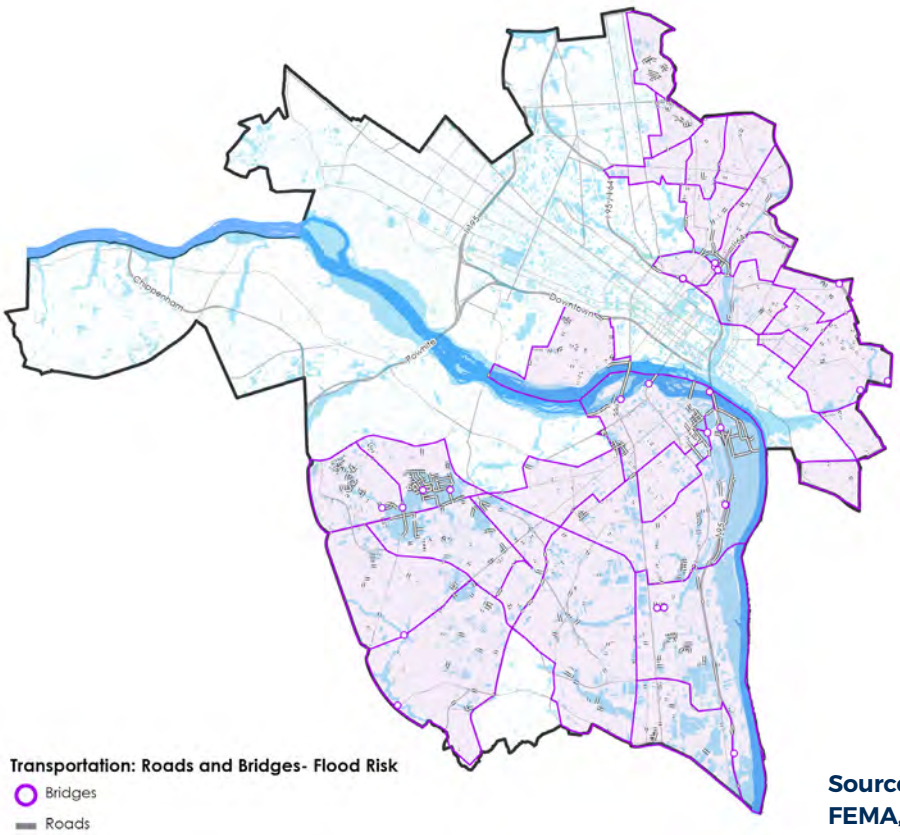

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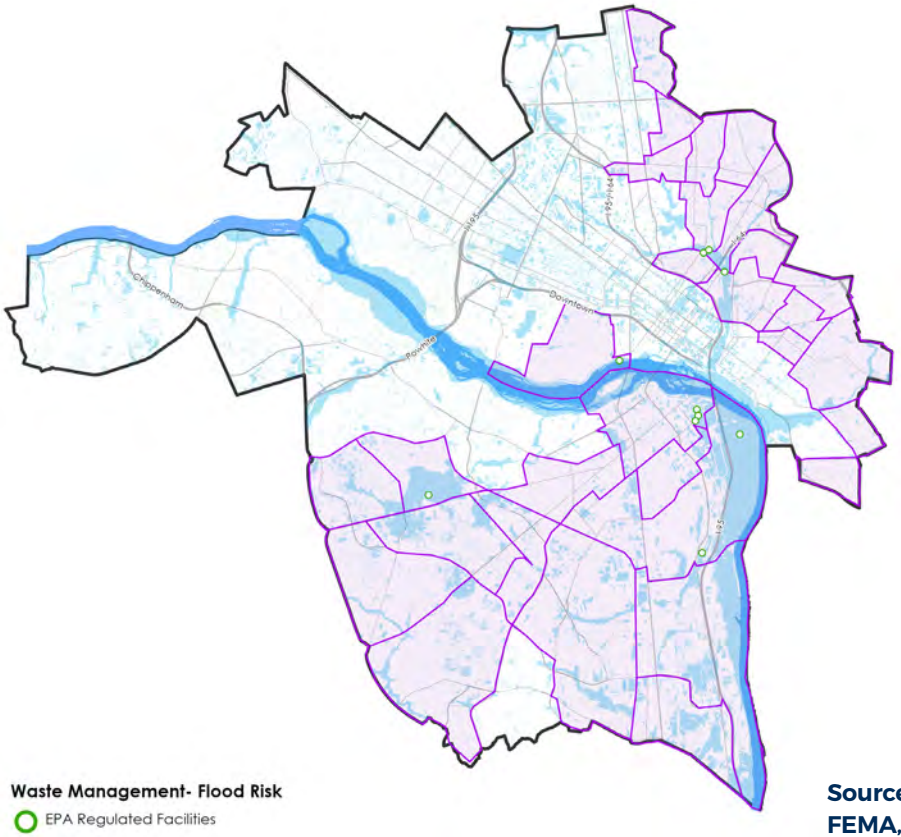

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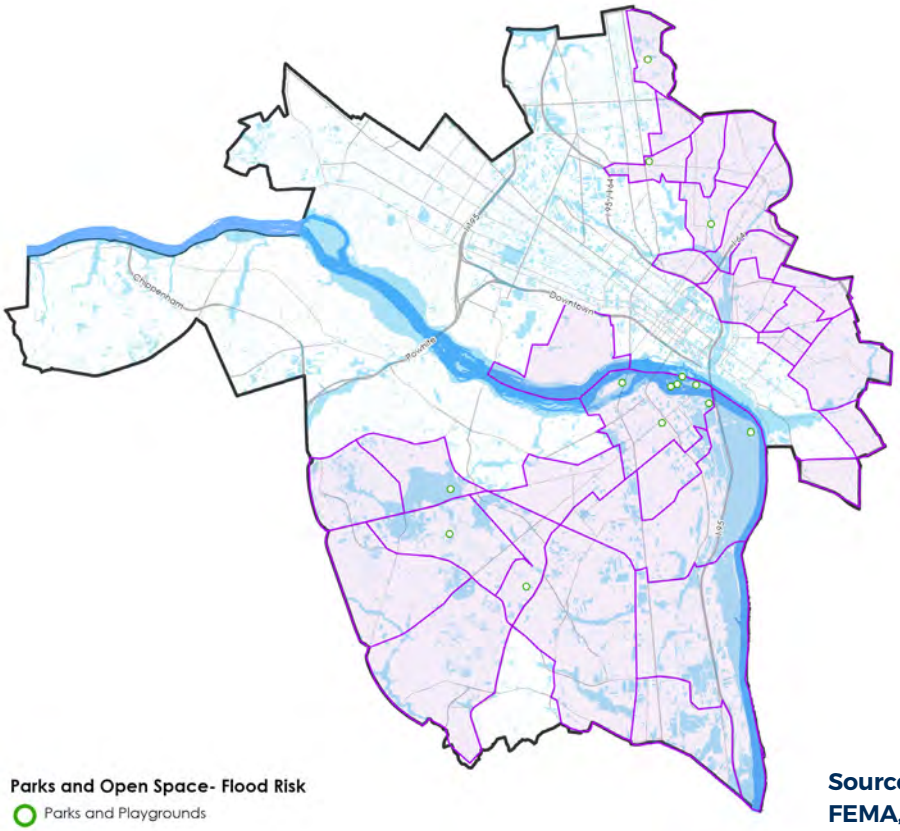

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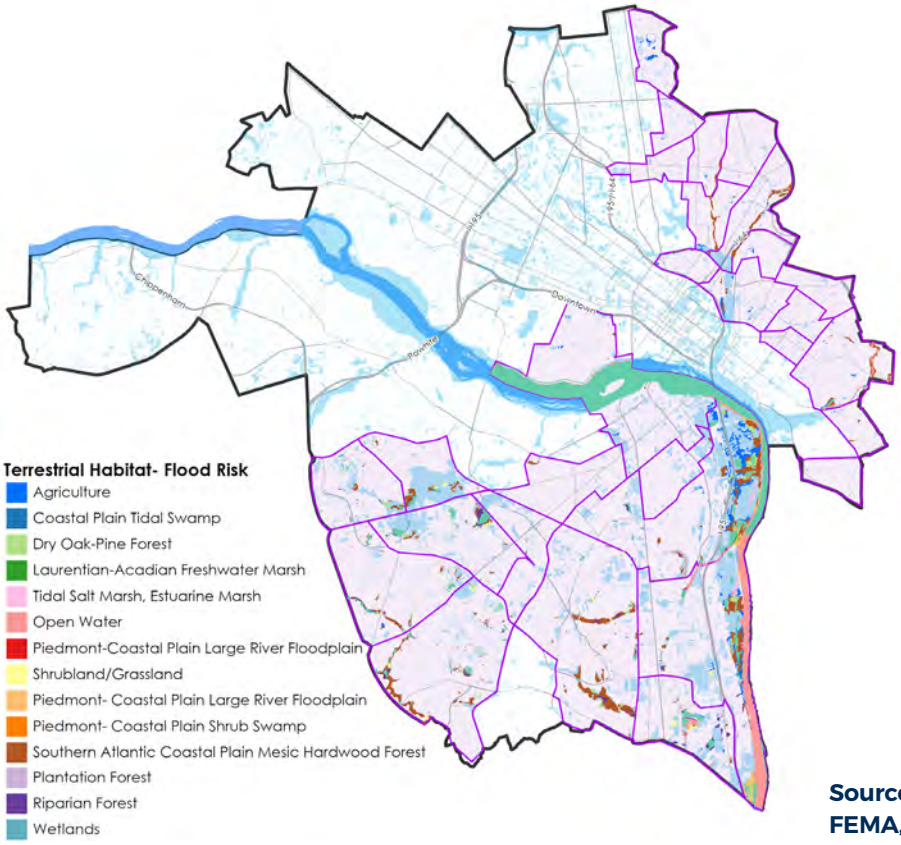

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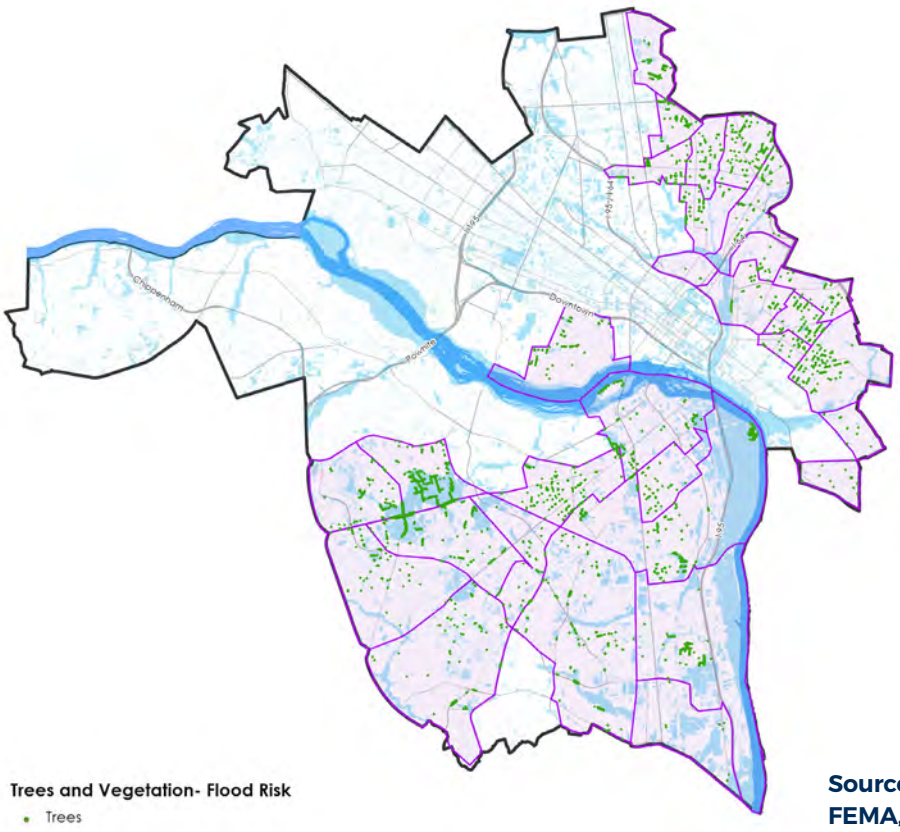

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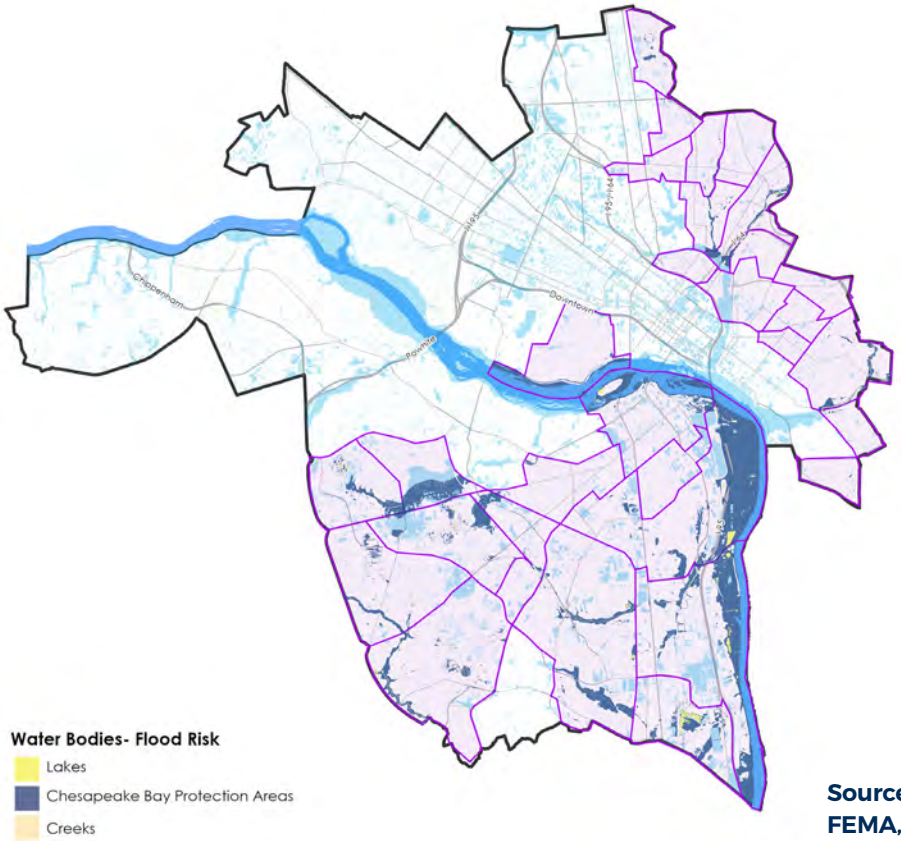


Sources: City of Richmond, Esri, FEMA, US Census Bureau

6.3 Prioritized Needs – Critical Flood Risk

Table 6.4 and the map figure that follows summarize the assets in the "most" socially vulnerable areas or that predominantly or exclusively serve socially vulnerable groups that have exposure to flooding risk from climate change. The name or address of these assets is included along with the stakeholder consequence ranking to support City prioritization of equity-centered climate resilience strategies and action for these critical resources and areas.

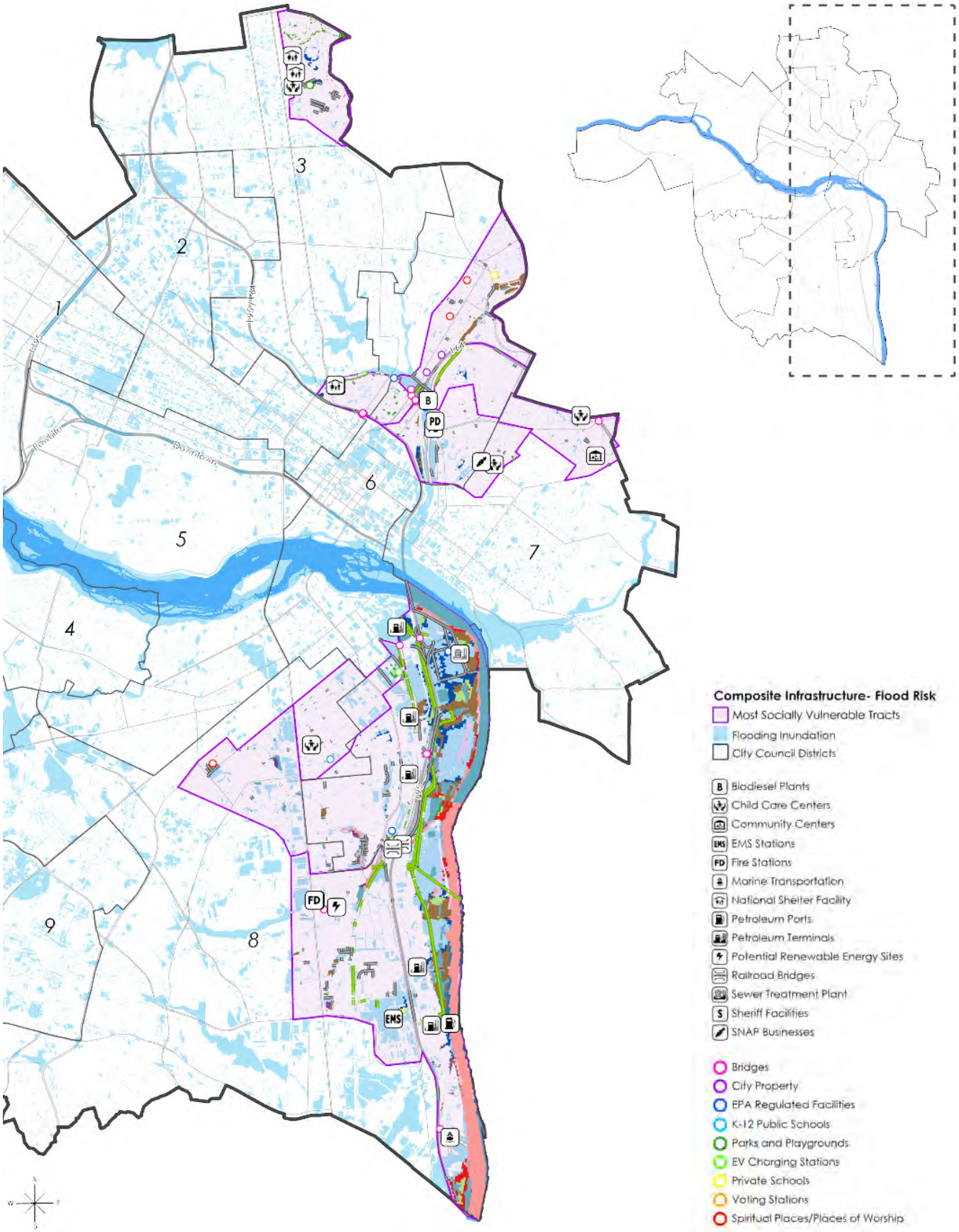
Table 6.4 – Prioritized Needs – Critical Flood Risk

Asset Category	Asset Name	Assets at Risk in Highly Socially Vulnerable Areas	Resources Serving SV Groups at Risk Outside Most SV areas	Units	Critical Flood Risk	
					Most Vulnerable Assets with exposure to Critical Flood Risk (located within or serving socially vulnerable groups)	Conse-quence
Community Buildings	Community Centers	2	0	centers	Creighton Court Community Center; Calhoun Community Center and Playground	
	Religious Centers	4	0	Centers	Saint Kim Taegon Catholic Church; Fifth Street Baptist Church; Bethlehem Baptist Church; Grayland Baptist Church	
	Voting Stations	3	0	stations	Calhoun Center; John Marshall High School; 5th Street Baptist Church	
Economic Development and Planning	CARE Zones	2	11	zones	*Belt Boulevard, *Brookland Park Boulevard, *Fulton Hill, *Hull Street, *Jackson Ward, *Midlothian Turnpike, *North Avenue, *North 25th Street, *Shockoe Bottom, *Swansboro, *Upper Hull Street, Lombardy/Chamberlayne, Meadowbridge,	
	Community Unit Plans	4	0	plans	See map for locations	
	Enterprise Zones	3	0	zones	III (2746.8 acre), III (47.1 acre), 1 (3611.2 acre)	
Education	Childcare Centers	4	0	centers	North Richmond Branch YMCA; Fairfield Elementary School; Oak Grove Child Care Center; Bethlehem Baptist Church Child Development Center	
	K12 Public Schools	4	0	schools	Oak Grove Elementary School; John Marshall High School; REAL School; Thomas H Henderson Middle School	
	Private Schools	1	0	schools	Geara Group/Educational Developmental Center	
Energy Infrastructure	Biodiesel Plants	1	0	facilities	Reco Biodiesel Inc	
	Electric Power Transmission Lines	16.2	0.0	miles	See map for locations	
	Electric Vehicle Charging Stations	2		stations	1001 E 4th St (ID: 187899), 1001 E 4th St (ID: 188105)	
	Petroleum Ports	1	0	ports	Port of Richmond	
	Petroleum Terminals	5	0	terminals	Bukeye Terminals, LLC; Chevron Richmond Terminal; First Energy Corportation; Kinder Morgan Southeast Terminals- Richmond; Kinder Morgan Southeast Terminals- Richmond 2	
	Potential Renewable Energy Sites	1	0	sites	Madison Arms I and II	
Food System Assets and Resources	SNAP Businesses	1	10	businesses	See map for locations	
Government Facilities	City Property	2	0	properties	Highland Park Southern Tip: 1509 Court St; Highland Park Southern Tip: 1806 5th Ave	
Health and Social Services	Social Services	0	1	services	*DSS East District Center - 701 North 25th Street Richmond VA 23223	

Consequence Scale				
Low	Medium-Low	Medium	Medium-High	Low

Asset Category	Asset Name	Assets at Risk in Highly Socially Vulnerable Areas	Resources Serving SV Groups at Risk Outside Most SV areas	Units	Critical Flood Risk	
					Most Vulnerable Assets with exposure to Critical Flood Risk (located within or serving socially vulnerable groups)	Consequence
Historic	National Register Historic Districts	12	0	Districts	Union Hill; Southern Stove Works; Chesapeake Warehouses; Hebrew Cemetery; Pine Camp Tuburculosis Hospital; Richmond Nursing Home; Chesnut Hill-Plateau; Fairmount; Highland Park Plaza; Manchester Industrial; Baker School; American Tobacco Company	
	State Federal Historic Sites	6	0	sites	The Almshouse; Shockoe Hill Cemetery; Pine Camp Tuberculosis Hospital; Southern Stove Works Manchester; Fairmount School; Hebrew Cemetery	
Parks and Open Spaces	Parks and Playgrounds	2	0	parks	James River Park-Ancarrows Landing; Roy West Park (Washington Park)	
Public Housing Resources	HUD Multifamily Properties	0	2	properties	*Charnwood Forest 4325 Crutchfield St Richmond VA 23225, Blue Ridge Estates - 6507 Sugar Maple Dr. Richmond VA 23225	
	RRHA Housing	39	3	locations/ parcels	See map for locations	
Public Safety and Emergency Response	Cooling Centers	0	1	centers	*East District Center - 701 North 25th Street Richmond VA 23223	
	Correctional Facilities	2	1	facilities	*Medical College Of Virginia Security Ward - 401 North 12th Street Richmond VA 23219, Richmond City Jail - 1701 Fairfield Way Richmond VA 23223, Richmond Juvenile Detention Center - 1700 Oliver Hill Way Richmond VA 23219	
	EMS Stations	2	0	stations	Richmond Fire Department Company 21; Phillip Morris Fire Brigade	
	Fire Stations	1	0	stations	Richmond Fire Station 21	
	National Shelter System Facilities	3	0	facilities	John Marshall High School; The Calhoun Center; Henderson Middle School	
	Sheriff Facilities	3	0	facilities	Juvenile Detention Center; Oliver Hill Courts Building; Richmond Detention Center	
Stormwater and Sewer Infrastructure	Active StormwaterOutfall	154	0	units	See map for locations	
	Sewer Treatment Plant	1	0	plants	Anacarows Landing	
Terrestrial Habitat	Terrestrial Habitat	10	0	habitats/ locations	Open water; Riparian Forest; Agriculture; Southern Atlantic Coastal Plain Mesic Hardwood Forest; Coastal Plain Tidal Swamp; Piedmont-Coastal Plain Large River Floodplain; Dry Oak-Pine Forest; Tidal Salt Marsh- Estatuarine Marsh; Shrubland/ Grassland; Laurentian-Arcadian Freshwater Marsh	
Transportation Infrastructure - Bike/ Ped	Bike Infrastructure	0.59	0.0	miles	See map for locations	
Transportation Infrastructure - Marine	Marine Transportation	1	0	unit	5001 Deepwater Terminal Rd	
Transportation Infrastructure - Rail and Transit	Railroad Bridges	2	0	bridges	CSX Transportation, Goode Creek; CSX Transportation, Goode Creek	
	Rail Lines	13.7	0.0	miles	miles	
Transportation Infrastructure - Roads and Bridges	Bridges	15	0	bridges	See map for locations	
	Roads	14.9	0.0	miles	See map for locations	
Trees and Vegetation	Tree canopy (Street Trees and Trees Other)	929	0	trees	See map for locations	
Waste Management Infrastructure	EPA Regulated Facilities	4	0	facilities	City of Richmond Wastewater Treatement Plant; Bellemeade Power Station; Industrial Alloy Fabricators Inc; Reco Biodiesel, LLC	
Water bodies	Chesapeake Bay Protection Area	991.4	0.0	acres	See map for locations	
	Lakes	18	0	lakes	See map for locations	
	Creeks	4	0	creeks	See map for locations	

Consequence Scale				
Low	Medium-Low	Medium	Medium-High	Low


1
2
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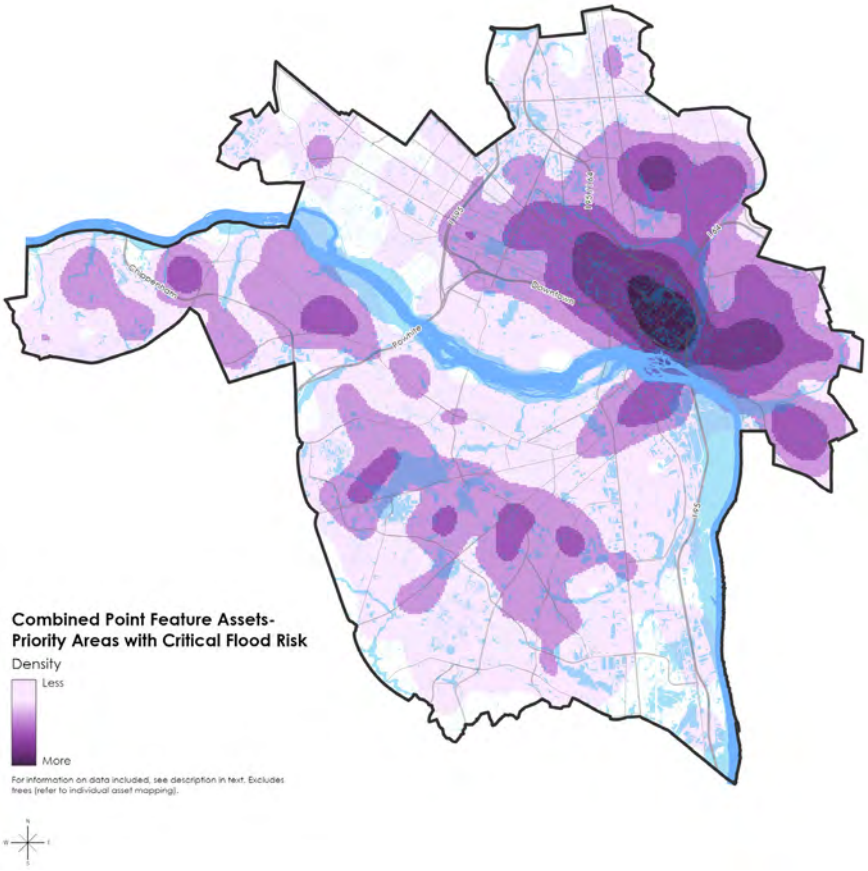
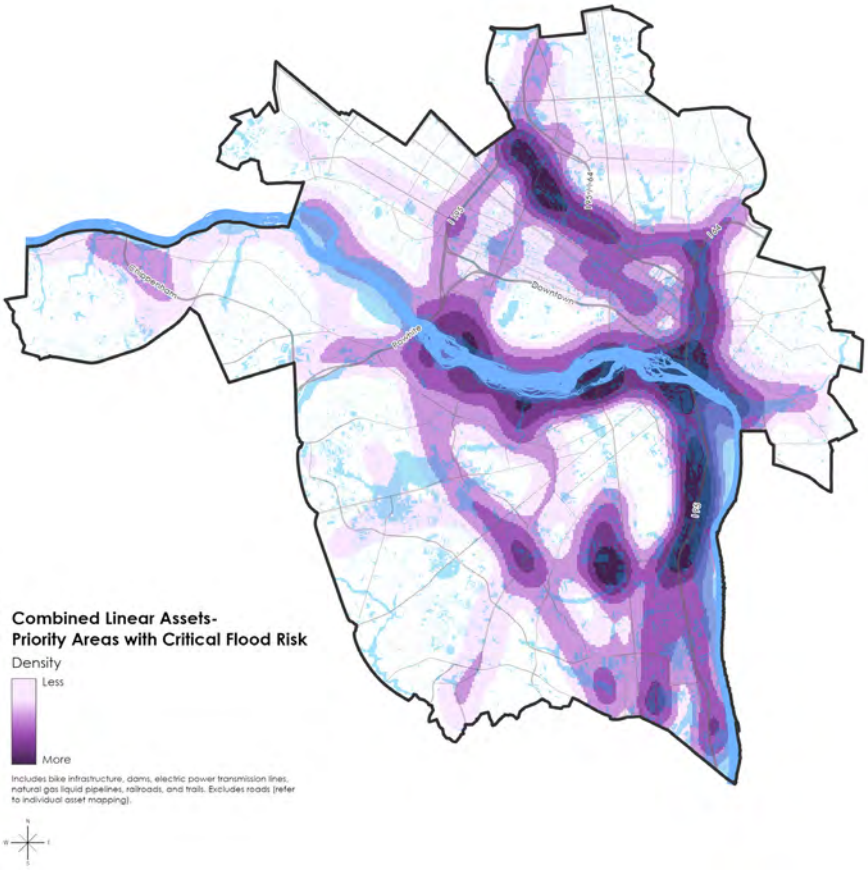
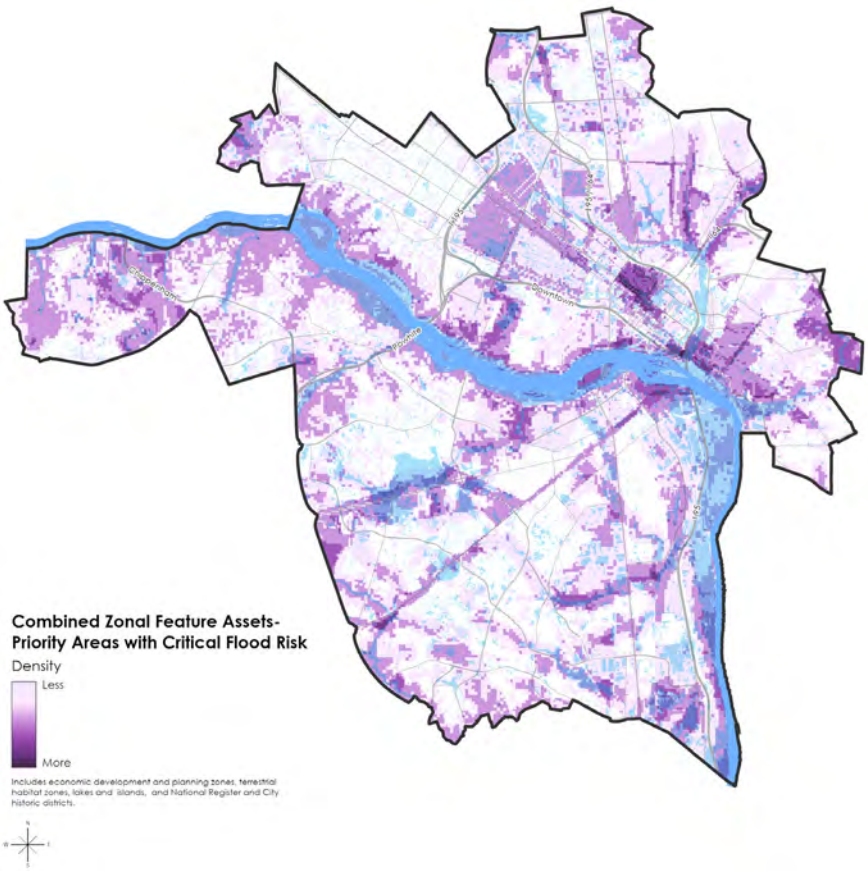
B
PD
FD
EMS
Composite Infrastructure- Flood Risk
Most Socially Vulnerable Tracts
Flooding Inundation
City Council Districts
Biodiesel Plants
Child Care Centers
Community Centers
EMS Stations
Fire Stations
Marine Transportation
National Shelter Facility
Petroleum Ports
Petroleum Terminals
Potential Renewable Energy Sites
Railroad Bridges
Sewer Treatment Plant
Sheriff Facilities
SNAP Businesses
Bridges
City Property
EPA Regulated Facilities
K-12 Public Schools
Parks and Playgrounds
EV Charging Stations
Private Schools
Voting Stations
Spiritual Places/Places of Worship


Combined Point Feature Assets-
Priority Areas with Critical Flood Risk
Density
Less
More
For information on data included, see description in text. Excludes trees (refer to individual asset mapping).


Combined Linear Assets-
Priority Areas with Critical Flood Risk
Density
Less
More
Includes bike infrastructure, dams, electric power transmission lines, natural gas liquid pipelines, railroads, and trails. Excludes roads (refer to individual asset mapping).


Combined Zonal Feature Assets-
Priority Areas with Critical Flood Risk
Density
Less
More
Includes economic development and planning zones, terrestrial habitat zones, lakes and islands, and National Register and City historic districts.

7. Recommendations

7.1 Resilience Recommendations

The RVAgreen 2050 Climate Equity Action Plan 2030 has identified key strategies and actions for reducing greenhouse gas emissions and increasing climate resilience, many of which address a number of the climate vulnerabilities and risks described in this report. Figure 7.1 presents additional or in some instances more detailed actions recommended to more fully address the key vulnerabilities and risks that have been analyzed and the priorities that have been identified in the full Climate Vulnerability and Risk Assessment.

Figure 7.1 - Recommended Actions to Address Vulnerability and Risk

Recommended Action	Vulnerability/ Risk Addressed	Time	Resilience Benefits	Equity Benefits	Related 2030 Action Plan Strategies
Design new homes for flood risk, for extreme storm events	Flood	2022-2025	Flooding and sea level rise resilience Extreme weather events resilience Community resilience	Racial equity and environmental justice Affordable housing Neighborhoods Health and well-being	Resilient Design Guidelines (BE-4.2)
Retrofit existing homes for flood risk, extreme storms	Flood	2022-2025	Flooding and sea level rise resilience Extreme weather events resilience Community resilience	Racial equity and environmental justice Affordable housing Neighborhoods Health and well-being	Climate-Ready Affordable Housing (C-1.1)

Recommended Action	Vulnerability/ Risk Addressed	Time	Resilience Benefits	Equity Benefits	Related 2030 Action Plan Strategies
Incentivize relocation of housing in areas of flood risk	Flood, Sea Level Rise	2026-2030	Flooding and sea level rise resilience Extreme weather events resilience Community resilience	Racial equity and environmental justice Affordable housing Neighborhoods Health and well-being	Resilient Design Guidelines BE-4.2)
Ensure public housing and community facilities have air conditioning (retrofit or new construction)	Heat	2022-2025	Flooding and sea level rise resilience Extreme weather events resilience Community resilience	Racial equity and environmental justice Affordable housing Neighborhoods Health and well-being	Climate-Ready Affordable Housing (C-1.1)
Establish backup power systems for critical facilities	Flood, Heat	2026-2030	Flooding and sea level rise resilience Extreme weather events resilience Community resilience	Government accountability Health and well-being	Municipal Resilient Infrastructure Assessment (BE-1.4) Resilient Design Guidelines (BE-4.2)
Consider a holistic review of the multiple threats/ stressors health care facilities experienced across the system during COVID - develop an improvement plan that incorporates climate risks as well	Flood, Heat	2022-2025	Flooding and sea level rise resilience Extreme weather events resilience Extreme heat resilience Community resilience	Racial equity and environmental justice Affordable housing Neighborhoods Health and well-being	Climate-Ready Community Fund (C-2.1) Organizational Collaboration (C-2.3)
Climate vulnerability assessment of the tree canopy specifically	Flood, Heat	2022-2025	Flooding and sea level rise resilience Extreme weather events resilience Extreme heat resilience	Racial equity and environmental justice Neighborhoods Health and well-being Engagement and communications	Urban Heat Island Reduction (ENV-2.1) Urban Forest and Green Space Planning (ENV-2.2)

Recommended Action	Vulnerability/ Risk Addressed	Time	Resilience Benefits	Equity Benefits	Related 2030 Action Plan Strategies
Establish historic resources protection programs, such as "keeping history above water" resources, green historic preservation, etc	Flood, Sea Level Rise, Heat	2022-2025	Flooding and sea level rise resilience Extreme weather events resilience Extreme heat resilience	Racial equity and environmental justice Affordable housing Neighborhoods Health and well-being	Community Partnerships Program (C-1.5) Organizational Collaboration (C-2.3)
Create business preparedness programs (not just insurance)	Flood, Sea Level Rise, Heat	2022-2025	Flooding and sea level rise resilience Extreme weather events resilience Extreme heat resilience Community resilience	Racial equity and environmental justice Government accountability Engagement and communications Community wealth	Climate Action and Resilience Information Navigator (C-1.3) Organizational Collaboration (C-2.3)
Install microgrids at critical facilities	Flood, Heat	2026-2030	Flooding and sea level rise resilience Extreme weather events resilience Extreme heat resilience Community resilience	Racial equity and environmental justice Government accountability Health and well-being	Municipal Resilient Infrastructure Assessment (BE-1.4) Solar Installation Incentives and Access (BE-3.2)
Modernize the grid	Flood, Heat	2022-2030	Flooding and sea level rise resilience Extreme weather events resilience Extreme heat resilience Community resilience	Racial equity and environmental justice Government accountability Health and well-being	Solar Installation Incentives and Access (BE-3.2)
Develop distributed energy, renewables, energy storage	Flood, Sea Level Rise, Heat	2022-2030	Flooding and sea level rise resilience Extreme weather events resilience Extreme heat resilience Community resilience	Racial equity and environmental justice Government accountability Health and well-being Community wealth	Solar Energy Education & Outreach (BE-3.1) Solar Installation Incentives and Access (BE-3.2)

7.2 Relevant strategies in the Draft RVAgreen Climate Equity Action Plan 2030:

Buildings and Energy Pathway

BE-1.4: Municipal Resilient Infrastructure Assessment: Conduct a climate vulnerability and risk assessment of all city property (including buildings and parcels). Identify and prioritize properties for specific resilience projects.

BE-2.1: Residential Energy Burden: Implement measures to reduce the energy burden of Richmond's most vulnerable communities and improve residential resilience to climate change.

BE-3.1: Solar Energy Education & Outreach: Provide equitable education and outreach to make homes and small businesses healthy, safe, and affordable through solar installations, focusing on frontline communities and reducing disproportionately high energy burden in these neighborhoods.

BE-3.2: Solar Installation Incentives and Access: Encourage solar installations through the removal of zoning restrictions, incentivizing opportunities, and increasing funding for microgrids.

BE-4.2: Resilient Design Guidelines: Develop Resilient Design Guidelines and require builders to incorporate design measures to reflect a changing climate, increased precipitation and flooding in concert with a public education campaign to convey the benefits of adaptive and resilient buildings.

Community Pathway

C-1.1: Climate-Ready Affordable Housing: Climate-Ready Affordable Housing: Develop and implement climate mitigation and resilience requirements for the Affordable Housing Trust Fund.

C-1.3: Climate Action and Resilience Information Navigator: Help small businesses, homeowners, and renters navigate programs and incentives for reducing emissions and increasing climate resilience.

C-1.4: Community Benefits Scorecard and Agreements: Develop tools with frontline communities to evaluate City development projects and ensure they address community priorities for climate action and resilience, and encourage use by private developers as well.

C-1.5: Community Partnerships Program: Develop a climate action and resilience neighborhood partnerships program.

C-2.1: Climate-Ready Community Fund: Establish a Climate-Ready Community grant program to provide funding to neighborhood-focused organizations to work with residents on climate action and resilience projects.

C-2.3: Organizational Collaboration: Partner with community leaders, organizations, and businesses to build community capacity for climate resilience.

C-2.4: Resilience Hubs: Create neighborhood resilience hubs in frontline communities.

Environment Pathway

ENV-1.3: Urban & Community Agriculture: Develop, fund, and implement an urban and community agriculture program.

ENV-2.1: Urban Heat Island Reduction: Develop, fund, and implement an urban heat island reduction plan and program.

ENV-2.2: Urban Forest and Green Space Planning: Use urban forest and green space planning to increase climate resilience.

ENV-3.1: Neighborhood Prioritization: Identify and prioritize extreme precipitation and flooding projects using community engagement and data.

ENV-3.2: Extreme Precipitation Resilience Planning and Operations: Increase planning and capacity for green infrastructure management and flood resilience measures.

ENV-3.3: Land Management Practices: Enhance land management practices to increase capacity for flood resilience measures.

Transportation and Mobility

TM-1.4: Climate Resilient Infrastructure: Develop a climate resiliency plan for transportation infrastructure that prioritizes projects using Envision and the Climate Equity Index.

TM-2.3: Residential Mobility and Complete Streets: Promote safely walkable and bikeable neighborhoods that connect Richmonders to jobs, necessities, and amenities throughout the city in alignment with the Richmond Connects Plan.

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9. Appendix A: Social Vulnerability Factors

Population Factors

Elderly: Old age is generally accompanied by an increased risk of certain diseases and disorders, along with changes in various social factors such as income loss and social isolation. The impacts of climate change worsen these risks, and can increase susceptibility to heat, pollutants, and vectorborne diseases for individuals 65 years and older. Conditions that limit mobility, and reduced physical ability make movement to avoid disasters challenging. In a study conducted to assess temperature variability and elderly mortality, research found that each 1-degree Celsius increase in summer temperature variability increased the death rate for elderly people with chronic conditions between 2.8 and 4.0 percent, depending on the condition. The mortality risk was 1 to 2 percent greater for those living in poverty and for African-Americans. The risks of these climate impacts, such as extreme heat, can further burden elderly populations given that older adults who own air-conditioning units may not utilize them during heat waves due to high operating costs. Additionally,

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studies have found associations between acute exposure to ambient ozone and increased risk of death, as well as an increased number of emergency room visits and hospital admissions among older adults.

Children: Children under 18 have an increased vulnerability to the impacts of climate change, having no or little direct control over the environment they live in. This increases their risks from climate-related disasters, and can require additional care and protection from harm. Furthermore, infants and children under 5 have substantial vulnerability to dehydration and heat stress, and there are more heat-related deaths among infants during heat waves. Children under 18 are also more susceptible to traumatic events that can result in long-term negative effects on health, social, and behavioral outcomes. Additionally, climate change impacts can expose pre-existing psychological vulnerabilities in children under 18.

Minorities: Minorities are more vulnerable to the impacts of climate change. Due to historic and institutional racism, they tend to live in more marginal and exposed areas that are more susceptible to climate impacts. For instance, minorities have a higher morbidity and mortality rate associated with extreme heat. In a heatwave study conducted in Los Angeles during 1989-1998, the African American mortality rate was double the city's average. Additionally, Hispanic or Latinx individuals are heavily represented in construction and crop and livestock production, and are three times more likely to die on the job from excessive heat than non-Hispanic/Latinx individuals. Latinx and Hispanics have the lowest rate of health insurance of any racial or ethnic group in the U.S., which limits their access to care. Native Americans tend to be among the most vulnerable, often living close to nature, in relatively natural environments rather than in cities, and growing and making much of the food and other products that they need to survive.

Female: The impacts of climate change on health, including increased exposures to heat, poor air quality, and extreme weather events, pose different risks for men and women. Exposure to climate change impacts such as poor air quality has a worse impact on women, due to increased rates of cases of air particulate matter in lung tissue and higher rates of anemia. Poor

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air quality is also associated with negative birth outcomes, and poses a risk for maternal and child health associated with stillbirth, intrauterine growth restriction, and congenital defects. Additionally, women can have a more difficult time recovering from a climate-related disaster due to having lower income than men.

Limited English Proficiency: Many implications of limited English proficiency (LEP) increase vulnerability to climate change. Individuals with LEP have high poverty rates and various language and cultural barriers. Additionally, those with LEP may have citizen status challenges, which make them more hesitant to seek out help. Furthermore, barriers such as accessing and affording mental health care, and limited counseling in native languages, limits their climate change adaptability and resilience. For example, during a flooding event, residents may face the challenge of communicating with emergency response personnel. Likewise, if residents are more socially isolated, they may be less likely to hear about upcoming events.

Health and Safety Factors

Health Opportunity Index: The Health Opportunity Index (HOI) is a measurement based on 13 indicators that reflect a wide variety of social determinants of health. The 13 indicators are categorized into four profiles: community environmental, consumer opportunity, economic opportunity, and wellness disparity. Each indicator, the profiles, and the HOI itself, provide implications of the opportunity for individuals to live a long and healthy life in each area. Additionally, the HOI explains approximately 60 percent of variation in Disability Free Life Expectancy in Virginia Census Tracts. A low health opportunity index can indicate poor air quality, income inequality, low education levels, limited access to care, and poor food accessibility, which are all factors that increase vulnerability to the impacts of climate change.

Disabilities: Persons with physical and mental disabilities have an increased vulnerability to the impacts of climate change. A disability is defined as "a person who has a physical or mental impairment that substantially limits one or more major life

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activity." Factors that contribute to that vulnerability can include bodily impairments, such as cognitive or hearing impairments, and activity and participation limitations that increase difficulties with evacuations. There is greater vulnerability during storms, floods and extreme heat; susceptibility to invasive disease; and the complex disability-related challenges of relocation and forced migration (i.e. finding new housing or support networks). Furthermore, individuals with disabilities have a lower survival rate than those without disabilities. Additionally, those with disabilities are vulnerable largely due to inequalities and exclusion from resilience and mitigation efforts. Older adults with mobility or cognitive impairments are likely to experience greater vulnerability to health risks due to difficulty responding to, evacuating, and recovering from extreme events. Systems designed to assist people in times of emergencies are often inaccessible to individuals with disabilities. Adaptive efforts such as ramps to enter shelters, accessible bathrooms, feasible evacuation transportation, and effective communication technologies on evacuation planning for those with impairments, are essential for reducing vulnerability.

Obesity: Since 1980, worldwide obesity has more than doubled, and obesity can be associated with highly elevated risks of adverse health outcomes. In a climate-related disaster, individuals with severe or morbid obesity may present challenges in emergency situations with regards to rescue, evacuation, transport, and suitable equipment, which increases their vulnerability. Obesity is a leading risk factor for morbidity and premature mortality, and climate impacts such as an extreme heat event, can increase the risk of heat exhaustion and mortality. Climate change impacts also increase exposure to obesity risk factors, since climatic extremes damage agricultural production and threaten food security.

Diabetes: Individuals with diabetes have an increased vulnerability to the impacts of climate change. Higher ambient temperature can negatively impact glucose metabolism, due to a reduction in body fat that is used to turn food into body heat. Research has found that

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for every 1-degree Celsius increase in outdoor temperature, there has been an approximate 4% increase of the total diabetes incidence in the United States per year between 1996 and 2009. Additionally, a 1-degree Celsius rise in environmental temperature could account for more than 100,000 new diabetes cases per year in the US. In hotter temperatures, dehydration and heatstroke increases morbidity and mortality in people with diabetes. People with diabetes are predisposed to cardiovascular events during heat waves and higher mortality from heart attack on days of high air pollution.

Adult Asthma: Adults with asthma are more vulnerable to the impacts of climate change. Climate change causes an increase in ozone pollution; coupled with greater concentrations of carbon dioxide and higher temperatures, pollen quantity may increase and induce longer pollen seasons. Ozone and pollen can worsen existing respiratory allergies and asthma, and serve as triggers for asthma attacks. More than twenty-six million Americans suffer from asthma, and each day ten people die from asthma related deaths. Although this map only shows adult asthma rates, it is important to note that inflammation in the lungs in children can impair lung development and lead to an increased risk of lung disease in adulthood.

COPD: Individuals with respiratory diseases are particularly vulnerable to the impacts of climate change. Air pollution from climate change-causing emissions sources does not only exacerbate existing respiratory disease, but can cause respiratory diseases as well. Individuals with COPD face increased mortality, higher rates of hospitalization, and exacerbation of COPD symptoms, and worse quality of life in cold weather seasons. Additionally, heat-wave-related mortality has been found to be higher among those with chronic respiratory disease, even when hospitalized. The risks associated with climate change impacts also include increased respiratory symptoms, increased rescue inhaler use, and decreased lung function in former smokers with COPD.

Coronary Heart Disease: With large day-to-day variations in temperature, individuals with coronary heart disease have significantly more heart attacks. Research has shown that outdoor temperature affects the rate of heart attacks, the rate of heart attacks increases on warm days following sudden temperature swings. The study

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results indicated that the risk of a heart attack increases by about 5 percent for every five-degree jump in temperature in degrees Celsius (9 degrees Fahrenheit). Swings of more than 25 degrees Celsius (45 degrees Fahrenheit) were associated with a greater increase in heart attack rates compared to a smaller increase with temperature swings of 10 to 25 degrees Celsius (18-45 degrees Fahrenheit). While the body generally has effective systems to respond to changes in temperature, rapid fluctuations can create more stress on those systems, which is a risk for those with coronary heart disease.

High Blood Pressure: Those with high blood pressure are vulnerable to the impacts of climate change. Variations in temperature can cause fluctuation in blood pressure, and may lead to severe drops in blood pressure, increasing the risk of falls in older adults. Furthermore, excessive heat serves as a risk for individuals taking medication for high blood pressure, since the medication can interfere with self-regulating body temperatures.

Kidney Disease: Individuals with kidney disease are vulnerable to the impacts of climate change, especially during extreme heat events. Studies have shown that during heat waves there is an increase in hospital admissions for acute kidney injury, and kidney failure becomes a leading cause of premature death, or death before life expectancy. Additionally, increased ambient temperature and sunlight have been recognized as prominent risk factors for the formation of kidney stones, to which those with kidney disease are already more susceptible. Researchers state this is caused by heat-associated sweating, which results in a reduction in urine volume, and leads to urinary supersaturation with stone-forming salts. Furthermore, the impacts of climate change also pose significant risk to chronic medical patients dependent on access to functioning health services. Dialysis patients are among the most vulnerable because of the potentially life-threatening impact of missed dialysis.

Self-Assessed Mental Health/ Stress: Self-assessed national public health surveys are used by the CDC to ensure their research includes a wide variety of demographics and socioeconomic characteristics. For those with mental health

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and stress, the impacts of climate change pose significant risks for factors such as PTSD, depression, general anxiety, suicidal thoughts, and increased substance abuse. Furthermore, excessive heat serves as a risk for individuals taking medication for mental health, since the medication can interfere with self-regulating body temperatures. Studies have shown that due to heat wave exposure, pre-existing mental illness was found to triple the risk of death, and there are increases in aggressive behavior, violence, and suicides. Likewise, there is an increase in hospital admissions and emergency room visits during heat waves for people with psychiatric illnesses.

Physical Health (Self-Assessed): Self-assessed health is increasingly being considered as a valid measure for predicting future health outcomes among elderly individuals. Older people who assess their physical health less favorably, have shown a significant correlation with functional decline and mortality. Individuals with poor physical health have difficulty responding to, evacuating, and recovering from extreme events.

Uninsured: Uninsured individuals may require extra resources to prepare, evacuate, and recover from emergency situations and the impacts of climate change. They are much more likely to have unmet health care needs, and are less likely to have a primary source of care. Furthermore, those who are uninsured have lower rates of health care use, and experience worse health outcomes, including increased rates of mortality. This significantly reduces climate change adaptability and resiliency for those who are uninsured.

Food Security (Low Food Access): Food insecurity and/or living in a food desert makes individuals vulnerable to the impacts of climate change. Research has shown that in major cities a very small share of total food consumed is processed and packaged locally. During an extreme weather event, such as flooding, the locations of food distributors impose a great risk for distribution and access. In most cities, neighborhoods are not equally served by the same number of food retail stores, creating local food availability vulnerabilities. Likewise, most food distributed to retail is delivered by truck, making roads a critical point of vulnerability. Furthermore, food prices will continue to rise as crop yields, livestock,

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and fish production are projected to decline due to climate change. Individuals with specific dietary needs may confront shortages of key foods, and depending on access may have to settle for inadequate options. Low-income individuals intersect with food security as well. As prices increase, affordable food options become limited; if there is not an adequate number of food retail stores, food banks, and other sources within reach of a certain area, this makes residents more vulnerable. This map identifies the low-income census tracts within Richmond where more than 100 housing units do not have a vehicle and are more than a ½ mile from the nearest supermarket, or a significant number of share residents are more than 20 miles from the nearest supermarket. Additionally, even with a vehicle there are low-income census tracts where a significant number or share of residents is more than 1 mile (urban) or 10 miles (rural) from the nearest supermarket.

Crime: Research has shown a strong relationship between temperature and both violent and property crime. With extreme heat, the likelihood of physical aggression and violence rises due to an increase in perceived hostility, anger, and irritability. The increase in number of interactions between individuals in warmer weather may be the primary driving force between the relationship of climate and crime. A study that conducted a 30-year assessment of monthly crime and weather data, has suggested that "between 2010 and 2099, climate change will cause an additional 22,000 murders, 180,000 cases of rape, 1.2 million aggravated assaults, 2.3 million simple assaults, 260,000 robberies, 1.3 million burglaries, 2.2 million cases of larceny, and 580,000 cases of vehicle theft in the United States." Additionally, neighborhoods with higher "social disadvantage" such as more female-headed households and unemployment are very likely to experience higher levels of violence as a result of abnormally warm temperatures. Climate change may also accelerate existing social instabilities or conflicts.

Household Factors

Single Parent Households: Single parent households are more likely to be in poorer neighborhoods and have fewer economic resources. Preschool children living with one parent, for example, can be more socially isolated, and this can have an impact on how they cope and respond to environmental hazards. Single parents are responsible for caregiving as well as providing family income, and therefore increase their vulnerability to the impacts of climate change.

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Custodial Grandparents: Compared to single parents, grandparents have a higher prevalence of physical health problems which make them vulnerable to the impacts of climate change. Studies have shown higher levels of obesity, hypertension, heart disease, limited physical functioning, and dissatisfaction with one's physical health in custodial grandparents. Additionally, custodial grandparents have reported emotional stress from financial constraints, and inadequate social support. Without adequate knowledge of the availability of specialized services, and many having limited transportation to available health service sites, the impacts of climate change pose a great risk to grandparents responsible for grandchildren under 18.

Renters: Renters, especially low-income tenants, are often neglected when it comes to strategies that seek to lessen the impact of climate change on households. Renters have a low climate change adaptability and resilience, given the limited and sometimes low-quality of housing stock, as well as the renter's limited ability to retrofit their place of residence to prepare for climate change. Additionally, renters, who may be more transient than homeowners, new to an area have less knowledge of local environmental hazards, such as floods, which reduce their ability to adapt to climate impacts.

65+ years living alone: Many elderly people who live alone are on a fixed income, which reduces their climate change adaptability and resilience. Additionally, individuals who are 65-years of age or older are more likely to be disadvantaged in terms of their ability to evacuate because of a disability, limited income, or lack of transportation. For example, 43 percent of single Social Security recipients aged 65 years or older depend on Social Security for 90% or more of their income. Research has shown that older Americans living alone may be at a higher risk for abuse from frauds or scams, regarding home improvements or repairs before or after extreme weather events. Likewise, staying with friends or family is not a viable option for isolated elderly lacking social support, and therefore increases their vulnerability to the impacts of climate change.

Income and Education Factors

Poverty: Individuals below the federal poverty level have fewer resources and receive less support, which reduces their ability to prevent, cope with, and adapt to climate change impacts. Climate change impacts increase the vulnerability of individuals below the poverty level, causing a rise in risks such as physical and mental illnesses, job loss, and decreased food security. Furthermore, individuals below the poverty level are more likely to depend a on climate sensitive employment, such as agriculture, or on low-income informal or hourly jobs. These methods of employment often have little job security and protection against climate-related risks and disruptions. Additionally, low-income households generally spend a larger portion of their budgets on necessities like energy than other consumers.

Related to adaptive capacity: Poverty reduction is largely driven by asset growth. With reduced income and asset losses due to natural disasters, asset growth slows down, and diminishes poverty reduction. For climate resilience for individuals below the poverty level, strategies should be designed in a way that includes those below the poverty level, and should aim overall to reduce poverty.

Working Outdoors: Individuals who work outdoors are among the first to be exposed to the impacts of climate change. Outdoor workers include farmers and other agricultural workers, construction workers, transportation workers, paramedics, firefighters, police, and other first responders. According to the EPA, the risks of climate change impact outdoor workers through "increases in temperature, poor air quality, extreme weather, diseases transmitted by ticks and mosquitoes, industrial exposures, and damage to infrastructure." Extreme heat may result in more heat-related illnesses such as heat stroke, heat exhaustion, and fatigue for outdoor workers. Higher temperatures can also increase the risk of respiratory illness among workers. Additionally, the impacts of climate change generate risky conditions for workers involved in disaster response, rescue, and cleanup.

SNAP/Food stamps: Disruptions in government functions during climate disasters may impact distribution of SNAP/food stamp benefits. Additionally, individuals who receive SNAP/food stamps in areas of low food security may have low adaptability and resilience to climate impacts. By releasing benefits early in anticipation of an extreme weather event such as a hurricane, individuals are able to prepare for closures and other obstacles that occur following a storm. Studies have shown an increase in the number of unemployment claims following a natural disaster. Therefore, ensuring proper outreach for individuals to apply for benefits, and potentially increasing benefits for those already enrolled, can enhance their climate resilience abilities. Additionally, the impacts of climate change pose risks to the distribution of benefits when communication systems are disrupted.

Public Assistance Income: According to the U.S. Census Bureau, public assistance income refers to "assistance programs that provide either cash assistance or in-kind benefits to individuals and families from any governmental entity." For example, social security public assistance income is designed to provide benefits and services in retirement, on death, during the birth and childhood of infants, for disability, unemployment and for sickness and long-term illness. For climate resilience, public assistance income must be able to change as the demand changes, while facing the challenge of slower economic growth. This includes demands such as unemployment coverage, which may increase after a natural disaster. Additionally, the impacts of climate change pose risks to the distribution of benefits when communication systems are disrupted after a natural disaster. The number of households receiving public assistance significantly correlate with households living in poverty or with insufficient resources.

Housing Cost Burden: Housing

expenditures that exceed 30 percent of household income have historically been viewed as an indicator of a housing affordability problem. If a household exceeds 30 percent of its income for housing costs it is considered burdened, and burdened households have less ability to deal with the impacts of climate change such as rising energy and food costs, natural disasters, and property damage from floods. Younger adults are spending approximately 45 percent of their income on rent in their first decade in the workforce. Additionally, the share of renter households than spent 50 percent of more of monthly income on rent, has increased by 42 percent between 2001 and 2015, to a total of 17 percent. This can limit household consumption and reduce economic mobility, which limits climate adaptability and resilience.

Limited Education: Education can play an important role in reducing the negative impacts of extreme climate events in various ways. Formal education is considered as a direct way in which individuals obtain knowledge, skills, and competencies that can influence their adaptive capacity. Furthermore, studies have shown that education improves socio-economic status, since a higher education generally increases earnings. Individuals without a high school degree are more than twice as likely to live in inadequate housing compared to those with some college education. Additionally, 38 percent of Americans without a high school degree do not have health insurance, compared to 10 percent with a college degree. Furthermore, the level of education is highly correlated with access to weather forecasts and warnings as well as the types of technologies used to access weather information. Without adequate access to information, individuals cannot respond and prepare for hazards appropriately.

Unemployment: Individuals who are unemployed will have a harder time relocating from areas impacted by climate change, and would require substantial aid to repair or rebuild their home in the event of a natural disaster. Furthermore, those who are unemployed cannot economically contribute to recovery from a disaster within a community, which results in a slower recovery process.

Housing Choice Voucher: The Housing Choice Voucher Program provides rental assistance to qualified low-income individuals and families to afford decent, safe, and sanitary housing. Housing can include single-family homes, townhouses, and apartments, and is not limited to units located in subsidized housing projects. However, the largest concentration of Housing Choice Vouchers is within the inner city in subsidized housing projects, which further contains poverty to those locations. A prolonged concentration of poverty can exacerbate adverse health outcomes such as diabetes, asthma, and lung disease, and lead to an increase in mortality rates. Additionally, residences with low economic standing are associated with poorer health care access, being uninsured, and higher hospitalization rates, which increase vulnerability to the impacts of climate change.

Housing and Transportation Factors

Multi-Unit Structures: Multi-unit structures, defined in this data set as buildings containing 10 or more housing units, are vulnerable to the impacts of climate change. During a climate event such as a natural disaster, individuals living in multi-unit housing have limited access and limited ability to evacuate due to their dense population. In multi-unit structures where residents rely on elevators, electricity loss makes it difficult, if not impossible, for elderly residents and those with disabilities to leave the building to obtain food, medicine, and other needed services.

Mobile Homes: Mobile homes are often isolated with limited or no access to public transportation or highways, limiting food access, first responders' access, and evacuation ability. The structure of mobile homes often have no strong foundation or basement, which increases their vulnerability to climate change risks such as extreme flooding. In the event of a climate-related natural disaster, mobile home parks could see significant destruction of personal property and displacement of their residents.

Crowding: Crowding, where there are more people than rooms in a household, increases psychological distress, and can contribute to the spread of communicable diseases among residents. While a lack of privacy can result in stress, difficult social interactions, and an increase in behavioral problems for all household members, children appear to be the most vulnerable. Research has found that an increase in crowded conditions is positively associated with social withdrawal among children. Furthermore, parents in overcrowded homes often show less responsive parenting. Children are socialized within the home to learn roles and relate to others, and their degree of crowding can correlate with differences in child wellbeing across socioeconomic statuses. The lack of a comfortable, quiet space can lead children to have difficulties studying and reading, affecting their school performance. All of these factors can increase the vulnerability of members of a crowded household to climate impacts.

No vehicle access: Individuals in a household without a vehicle lack mobility certainty, and are less able to move to an area of refuge during a climate change impact, such as an air-conditioned cooling center during extreme heat, or a shelter during severe flooding. By having a lack of mobility certainty during a natural disaster, individuals without vehicle access have a reduced climate change adaptability and resilience.

No Central AC: Individuals with no central AC have low climate change adaptability and resilience. Climate change impacts such as extreme heat, are associated with increased risk for those dying from cardiovascular, respiratory, cerebrovascular, and some specific cardiovascular diseases, such as ischemic heart disease, congestive heart failure, and myocardial infarction. Additionally, extreme heat can cause risks such as heat exhaustion and heat stroke.

Emergency and transitional shelters (with sleeping facilities) for people experiencing homelessness: In 2017, over 553,000 Americans were homeless. Emergency and transitional shelters serve as a safety net and important alternative to living on the streets for a number of children, youth, individuals, and families experiencing homelessness. Climate-related disasters lead to displacement, which increases the need for emergency and transitional shelters, and causes greater exposure to health risks. Homelessness is associated with both racial and ethnic disparities, and children experiencing homelessness have a 25% greater risk of poor health and higher mortality rates in adulthood.

Group homes intended for adults; Residential treatment centers for adults: Group homes and residential treatment centers are facilities that may offer housing, and provide personal care and medical services for adults. Group homes often service the elderly and individuals with disabilities, which increases their vulnerability. A climate-related disaster may result in power outages that can limit communication for emergency services, and severely impact those who rely on refrigerated mediations, or use life-sustaining equipment.

Internet Access: Access to computers and internet technology is a crucial resource for connecting people to the information and skills they need in areas such as education, employment, and health. Many individuals in low- and middle-income communities especially, depend on public computer and internet access for information. Additionally, the internet can provide almost instantaneous communication, and therefore many emergency services use it as a method of distributing important information. Without access to internet, through either a home-based or cellular data subscription, households may be limited in their access to this information.

9. Appendix B: Statistical Outputs – Social Vulnerability Sensitivity & Adaptive Capacity

Sensitivity Variables	poverty	65+	<18	disability	obesity	asthma	COPD	heart disease	high blood press	kidney disease	poor mental health	poor physical health	grandparent/ grandchild	work outdoors	SNAP	public assistance	nonwhite	single parent	multiunit	mobile homes	crowding	crime	housing cost
poverty																							
65+	-0.49																						
<18	0.37	0.04																					
disability	0.45	0.09	0.6																				
obesity	0.6	-0.11	0.76	0.84																			
asthma	0.83	-0.32	0.65	0.74	0.9																		
COPD	0.65	0	0.78	0.8	0.96	0.9																	
heart disease	0.33	0.35	0.72	0.78	0.86	0.67	0.91																
high blood press	0.3	0.29	0.73	0.82	0.9	0.69	0.88	0.97															
kidney disease	0.45	0.24	0.73	0.82	0.91	0.76	0.93	0.98	0.97														
poor mental health	0.88	-0.44	0.6	0.64	0.84	0.96	0.85	0.56	0.56	0.64													
poor physical health	0.67	-0.07	0.78	0.81	0.98	0.92	0.99	0.88	0.87	0.91	0.88												
grandparent/ grandchild	-0.06	0.07	-0.06	0.11	0.17	0.14	0.12	0.17	0.22	0.19	0.08	0.13											
work outdoors	0.11	-0.05	0.32	0.23	0.4	0.25	0.35	0.32	0.32	0.26	0.34	0.4	0.01										
SNAP	0.75	-0.23	0.79	0.69	0.85	0.89	0.87	0.67	0.67	0.75	0.86	0.88	0.06	0.3									
public assistance	0.6	-0.23	0.57	0.57	0.7	0.74	0.72	0.55	0.55	0.63	0.71	0.72	0.24	0.09	0.82								
nonwhite	0.6	-0.16	0.61	0.83	0.94	0.9	0.86	0.76	0.84	0.84	0.8	0.89	0.26	0.28	0.77	0.65							
single parent	0.56	-0.26	0.58	0.66	0.83	0.8	0.75	0.6	0.66	0.67	0.76	0.78	0.33	0.29	0.73	0.63	0.81						
multiunit	0.33	-0.27	-0.35	-0.22	-0.23	-0.02	-0.21	-0.34	-0.37	-0.28	0.04	-0.2	-0.2	-0.18	-0.06	-0.05	-0.1	-0.11					
mobile homes	0.15	-0.08	0.1	-0.06	0.06	0.09	0.12	0.03	-0.02	-0.04	0.22	0.14	-0.05	0.47	0.04	-0.06	-0.02	0	-0.02				
crowding	0.41	-0.26	0.54	0.28	0.51	0.48	0.49	0.33	0.33	0.32	0.57	0.54	-0.02	0.67	0.54	0.28	0.38	0.43	-0.09	0.5			
crime	0.55	-0.29	0.14	0.38	0.48	0.54	0.46	0.31	0.31	0.36	0.56	0.48	0.06	0.22	0.47	0.34	0.49	0.48	0.28	0.07	0.23		
housing cost	0.7	-0.36	0.11	0.48	0.51	0.65	0.48	0.29	0.31	0.36	0.68	0.51	0.02	0.18	0.39	0.36	0.6	0.47	0.33	0.28	0.27	0.53	
female	0.01	0.17	0.27	0.1	0.04	0.1	0.08	0.09	0.1	0.13	0.01	0.05	-0.07	-0.25	0.17	0.12	0.06	0.08	0.03	-0.25	-0.1	-0.18	-0.14

Principal Component Analysis

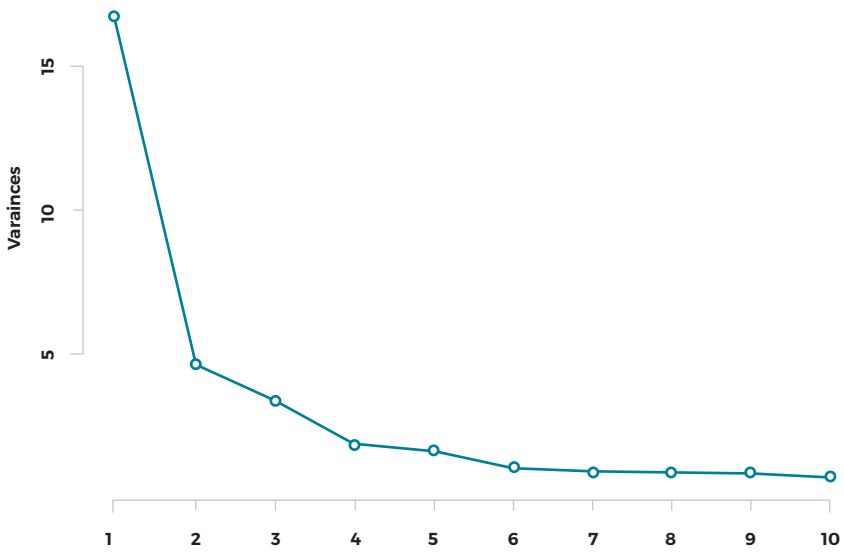
There are several "rules of thumb" for determining a cutoff point for the number of variables that explain the variance in data, including using the variables (or principal components) that explain 70% or 90% of the variance.[1] As shown in the table below, 90% of the variance in the social vulnerability scoring can be explained using just 10 of the 36 variables in this analysis.

Another rule of thumb is to use a scree graph like the one below where the variables are plotted along the x-axis and variance associated with each component is on the y-axis. The "elbow" in the graph represents a potential cut-off point for principal components of variation – a sometimes subjective test.

Adaptive Capacity Variables	poverty	no HS diploma	limited English	65+ living alone	unemployment	no vehicle	renter	uninsured	no central AC	HOI	HCV	shelters
poverty												
no HS diploma	0.59											
limited English	0.12	0.5										
65+ living alone	-0.27	-0.19	-0.19									
unemployment	0.66	0.53	0.1	-0.08								
no vehicle	0.82	0.59	-0.01	0	0.59							
renter	0.69	0.25	0.12	-0.25	0.33	0.56						
uninsured	0.4	0.76	0.69	-0.26	0.37	0.24	0.31					
no central AC	0.66	0.79	0.15	-0.2	0.58	0.74	0.36	0.46				
HOI	-0.53	-0.28	0.02	0.17	-0.37	-0.4	-0.53	-0.24	-0.36			
HCV	0.17	0.45	0.11	-0.02	0.33	0.15	0.04	0.51	0.37	-0.08		
shelters	0.12	-0.1	0.02	-0.1	0.05	0.06	0.17	0.05	0.04	-0.16	-0.04	
group homes	0.06	0.02	0.02	-0.03	0.02	0.07	0.1	0.2	0.06	-0.19	0.22	0.17

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10
Standard	4.10	2.17	1.85	1.39	1.28	1.03	0.98	0.96	0.93	0.86
Proportion	0.46	0.13	0.09	0.05	0.04	0.03	0.03	0.02	0.02	0.02
Cumulative	0.46	0.58	0.67	0.73	0.77	0.80	0.83	0.85	0.87	0.90

Figure 8.1: Scree graph produced in R



[1] "How Many Components should be Retained from a Multivariate Time Series PCA?," Rea and Rea: https://arxiv.org/pdf/1610.03588.pdf.

9. Appendix C: Asset Vulnerability Stakeholder Scoring

Communications Infrastructure

Assets	Heat Threats			Water Threats		
	Sensitivity	Adaptive Capacity	Combined Heat Vulnerability Score	Sensitivity	Adaptive Capacity	Combined Water Vulnerability Score
Communications Infrastructure	1.5	1.75	3.25	2	1.6	3.6

Community Buildings

Assets	Heat Threats			Water Threats		
	Sensitivity	Adaptive Capacity	Combined Heat Vulnerability Score	Sensitivity	Adaptive Capacity	Combined Water Vulnerability Score
Libraries and Community Centers	2.4	2.13	4.53	2.24	2.25	4.49
Museums	2.14	2.08	4.22	2.06	2.21	4.27
Religious Centers	2.5	2	4.50	2.13	2	4.13
Voting Stations	2.57	2.13	4.70	2.38	2.25	4.63

Economic Development and Planning

Assets	Heat Threats			Water Threats		
	Sensitivity	Adaptive Capacity	Combined Heat Vulnerability Score	Sensitivity	Adaptive Capacity	Combined Water Vulnerability Score
Convention Center	1.78	2.17	3.95	2	2.43	4.43
Fortune 500 Companies	2.4	2.43	4.83	2.63	2.63	5.26
Planning Zones, Plan Areas and Districts*	2.25	2.13	4.38	2.25	1.86	4.11

*CARE, Art District Incentive, and Enterprise Zones; Community Unit and Development Plans; Design Overlay District

Education

Assets	Heat Threats			Water Threats		
	Sensitivity	Adaptive Capacity	Combined Heat Vulnerability Score	Sensitivity	Adaptive Capacity	Combined Water Vulnerability Score
Childcare Facilities	2.5	2	4.50	2.13	2	4.13
Colleges and Universities	1.95	1.68	3.63	1.87	1.75	3.62
K12 Public Schools	2.59	2.41	5.00	2.47	2.31	4.78
Private Schools	2	1.5	3.50	1.86	1.5	3.36

Energy Infrastructure

Assets	Heat Threats			Water Threats		
	Sensitivity	Adaptive Capacity	Combined Heat Vulnerability Score	Sensitivity	Adaptive Capacity	Combined Water Vulnerability Score
Biodiesel Plants	1.4	2	3.40	2	2.4	4.4
Electric Power Transmission Lines	3	2.4	5.40	2	2.2	4.2
Electrical Substations	2.67	2.2	4.87	2.83	2.4	5.23
Natural Gas Pipeline	1.5	2.2	3.70	1.33	2.4	3.73
Non Gasoline Alternative Fueling Stations	1.5	1.33	2.83	1.4	2	3.4
Petroleum Ports	1.67	2.5	4.17	2.83	2.6	5.43
Petroleum Terminals	1.67	2.5	4.17	2.83	2.6	5.43
Potential Renewable Energy Sites	1.17	1	2.17	1.5	1	2.5

Food System Assets and Resources

Assets	Heat Threats			Water Threats		
	Sensitivity	Adaptive Capacity	Combined Heat Vulnerability Score	Sensitivity	Adaptive Capacity	Combined Water Vulnerability Score
Food Pantries and Warehouses	2.17	2	4.17	2.17	2	4.17

Government Facilities

Assets	Heat Threats			Water Threats		
	Sensitivity	Adaptive Capacity	Combined Heat Vulnerability Score	Sensitivity	Adaptive Capacity	Combined Water Vulnerability Score
City Property	2.2	2.33	4.53	2.13	2.29	4.42
Court System	2.1	2.25	4.35	2.25	2.25	4.5
State Government	2	2	4.00	2.13	2.43	4.56

Health and Social Services

Assets	Heat Threats			Water Threats		
	Sensitivity	Adaptive Capacity	Combined Heat Vulnerability Score	Sensitivity	Adaptive Capacity	Combined Water Vulnerability Score
Homeless Facilities	2.5	2.17	4.67	2.17	2.33	4.5
Hospitals	2.23	1.71	3.94	2.19	2.06	4.25
Nursing Homes	2.5	2.17	4.67	2.17	2.33	4.5
Other Health	1.86	1.71	3.57	2	2	4
Social Services	2.5	2.17	4.67	2.17	2.33	4.5

Historic

Assets	Heat Threats			Water Threats		
	Sensitivity	Adaptive Capacity	Combined Heat Vulnerability Score	Sensitivity	Adaptive Capacity	Combined Water Vulnerability Score
Historic Sites	2.4	2.71	5.11	2.75	3	5.75

Public Housing Resources

Assets	Heat Threats			Water Threats		
	Sensitivity	Adaptive Capacity	Combined Heat Vulnerability Score	Sensitivity	Adaptive Capacity	Combined Water Vulnerability Score
RRHA / HUD Housing	2.7	2.51	5.21	2.46	2.6	5.06

Public Safety and Emergency Response

Assets	Heat Threats			Water Threats		
	Sensitivity	Adaptive Capacity	Combined Heat Vulnerability Score	Sensitivity	Adaptive Capacity	Combined Water Vulnerability Score
Emergency Operations	2.18	2.17	4.35	2.13	2.14	4.27
Fire Stations	1.95	2.23	4.18	2.13	2.33	4.46
Police / Sheriff	1.95	2.23	4.18	2.13	2.33	4.46
Social Services	2.5	2.17	4.67	2.17	2.33	4.5

Stormwater and Sewer Infrastructure

Assets	Heat Threats			Water Threats		
	Sensitivity	Adaptive Capacity	Combined Heat Vulnerability Score	Sensitivity	Adaptive Capacity	Combined Water Vulnerability Score
Sewer Treatment Plant	1.73	1.95	3.68	3	2.44	5.44
Stormwater & Sewer Infrastructure	1.46	1.75	3.21	3	2.75	5.75

Transportation Infrastructure

Assets	Heat Threats			Water Threats		
	Sensitivity	Adaptive Capacity	Combined Heat Vulnerability Score	Sensitivity	Adaptive Capacity	Combined Water Vulnerability Score
Airport	2.22	1.83	4.05	2.11	2	4.11
Bike and Pedestrian	2.5	2.31	4.81	2.54	2.23	4.77
Marine	1.25	1.17	2.42	2.36	2.29	4.65
Transit / Rail	2.13	1.8	3.93	2.38	2.07	4.45
Road	1.64	1.92	3.56	2.8	2.13	4.93

Waste Management Infrastructure

Assets	Heat Threats			Water Threats		
	Sensitivity	Adaptive Capacity	Combined Heat Vulnerability Score	Sensitivity	Adaptive Capacity	Combined Water Vulnerability Score
EPA Emergency Response Facilities	1.78	1.67	3.45	2.88	2.14	5.02
Solid Waste Landfill Facilities	1.5	1.78	3.28	2.4	2.22	4.62
Composting, Recycling, and MSW Facilities	1.91	1.8	3.71	2.45	2.2	4.65

Water Supply Infrastructure

Assets	Heat Threats			Water Threats		
	Sensitivity	Adaptive Capacity	Combined Heat Vulnerability Score	Sensitivity	Adaptive Capacity	Combined Water Vulnerability Score
Dams	1.46	1.75	3.21	3	2.75	5.75
Water Supply Infrastructure	1.91	2.11	4.02	2.33	2.5	4.83

Natural Assets

Assets	Heat Threats			Water Threats		
	Sensitivity	Adaptive Capacity	Combined Heat Vulnerability Score	Sensitivity	Adaptive Capacity	Combined Water Vulnerability Score
Water Bodies						
Protected Areas, Creeks and Lakes	2.62	2.25	4.87	2.85	2.08	4.93
Trees and Vegetation						
Trees and Vegetation	2.62	2	4.62	2.31	2.08	4.39
Terrestrial Habitat						
Protected Areas and Habitats	2.62	2.25	4.87	2.85	2.08	4.93
Parks and Open Spaces						
Cemeteries	2.55	2.25	4.80	2.5	2.1	4.6
Community Gardens	2.77	2.27	5.04	2.75	2.19	4.94
Parks and Playgrounds	3	2.29	5.29	3	2.29	5.29

9. Appendix D: Consequence Analysis

Communications Infrastructure

Assets	Consequence Total Score	Area of service loss	Duration of service loss	Cost of damage	Public safety impacts	Economic activities impacts	Public health impacts	Vulnerable populations impacts	Environmental impacts
Communications Infrastructure	15	2	2	1.5	2.5	2	2	2	1

Communications Infrastructure

Assets	Consequence Total Score	Area of service loss	Duration of service loss	Cost of damage	Public safety impacts	Economic activities impacts	Public health impacts	Vulnerable populations impacts	Environmental impacts
Libraries and Community Centers	18.4	2.29	2.43	2.64	2.14	1.85	2.39	2.73	1.94
Museums	16.8	2.1	2.43	2.71	1.81	2	1.94	2.14	1.67
Religious Centers	18.38	2	2.29	2.43	2.33	2	2.56	2.78	2
Voting Stations	20.05	2.43	2.57	2.71	2.44	2.13	2.5	2.89	2.38

Consequence Scale				
Low 8	**Medium-Low** 8.01-11.99	**Medium** 12-15.99	**Medium-High** 16-19.99	**Low** 20-24

Economic Development and Planning

Assets	Consequence Total Score	Area of service loss	Duration of service loss	Cost of damage	Public safety impacts	Economic activities impacts	Public health impacts	Vulnerable populations impacts	Environmental impacts
Convention Center	15.22	2.2	2.57	3	1.29	2	1.33	1.5	1.33
Fortune 500 Companies	17.4	2.67	2.5	2.67	1.67	2.57	1.83	2	1.5
Planning Zones, Plan Areas and Districts	19.13	2.25	2.2	2.43	2.43	2.71	2.38	2.88	1.86

*CARE, Art District Incentive, and Enterprise Zones; Community Unit and Development Plans; Design Overlay District

Education

Assets	Consequence Total Score	Area of service loss	Duration of service loss	Cost of damage	Public safety impacts	Economic activities impacts	Public health impacts	Vulnerable populations impacts	Environmental impacts
Childcare Facilities	18.38	2	2.29	2.43	2.33	2	2.56	2.78	2
Colleges and Universities	15.38	2.21	1.82	2.49	1.57	2	1.79	1.67	1.83
K-12 Public Schools	19.19	2.5	2.46	2.54	2.31	2.07	2.5	2.73	2.06
Private Schools	15.19	2.14	1.83	2.14	1.57	2.14	1.86	1.67	1.83

Economic Development and Planning

Assets	Consequence Total Score	Area of service loss	Duration of service loss	Cost of damage	Public safety impacts	Economic activities impacts	Public health impacts	Vulnerable populations impacts	Environmental impacts
Biodiesel Plants	12.67	1.33	1.67	1.67	2	1.33	1.33	1.33	2
Electric Power Transmission Lines	19.5	2.75	2.5	2.75	2.5	2.5	2.5	2.75	1.25
Electrical Substation	19.75	2.75	2.75	2.75	2.5	2.5	2.5	2.5	1.5
Natural Gas Pipelines	18.92	1.75	2.5	2.5	2.5	2.25	2.5	2.67	2.25
Non Gasoline Alternative Fueling Stations	13.33	1.67	2	1.67	1.33	1.67	1.33	1.67	2
Petroleum Ports	19.5	2	2.5	2.75	2.75	2.25	2.5	2	2.75
Petroleum Terminals	19.5	2	2.5	2.75	2.75	2.25	2.5	2	2.75
Potential Renewable Energy Sites	10.25	1.25	1.75	1.75	1	1.25	1	1.25	1

Food System Assets and Resources

Assets	Consequence Total Score	Area of service loss	Duration of service loss	Cost of damage	Public safety impacts	Economic activities impacts	Public health impacts	Vulnerable populations impacts	Environmental impacts
Food Pantries & Warehouses	17.6	2	2.4	1.8	2	2.4	2.4	2.6	2
Private Schools	15.19	2.14	1.83	2.14	1.57	2.14	1.86	1.67	1.83

Government Facilities

Assets	Consequence Total Score	Area of service loss	Duration of service loss	Cost of damage	Public safety impacts	Economic activities impacts	Public health impacts	Vulnerable populations impacts	Environmental impacts
City Property	18.6	2.57	2.17	2.86	2.67	2	2.17	2.17	2
Court System	18.57	2	2	2.57	2.86	1.86	2.57	2.71	2
State Government	18.76	2.71	2.29	2.86	2.57	2.33	2	2.17	1.83

Health and Social Services

Assets	Consequence Total Score	Area of service loss	Duration of service loss	Cost of damage	Public safety impacts	Economic activities impacts	Public health impacts	Vulnerable populations impacts	Environmental impacts
Homeless Facilities	19.57	2.67	2.5	2.33	2.33	2.4	2.5	2.67	2.17
Hospitals	19.34	2.37	2	2.42	2.52	2.4	2.63	2.83	2.17
Nursing Homes	19.57	2.67	2.5	2.33	2.33	2.4	2.5	2.67	2.17
Other Health	19.1	2.17	2.2	2.17	2.33	2.67	2.4	2.83	2.33
Social Services	19.57	2.67	2.5	2.33	2.33	2.4	2.5	2.67	2.17

Historic Resources

Assets	Consequence Total Score	Area of service loss	Duration of service loss	Cost of damage	Public safety impacts	Economic activities impacts	Public health impacts	Vulnerable populations impacts	Environmental impacts
Historic Sites	15.48	2	2.67	2.71	1.29	2.14	1.43	1.57	1.67

Historic Resources

Assets	Consequence Total Score	Area of service loss	Duration of service loss	Cost of damage	Public safety impacts	Economic activities impacts	Public health impacts	Vulnerable populations impacts	Environmental impacts
RRHA / HUD Housing	21	2.69	2.75	2.67	2.6	2.49	2.75	2.83	2.23

Public Safety and Emergency Response

Assets	Consequence Total Score	Area of service loss	Duration of service loss	Cost of damage	Public safety impacts	Economic activities impacts	Public health impacts	Vulnerable populations impacts	Environmental impacts
Emergency Operations	19.24	2.36	2.28	2.42	2.76	2.08	2.61	2.9	1.83
Fire Stations	18.8	2	2.2	2.54	2.76	2.01	2.54	2.76	2
Police / Sheriff	18.8	2	2.2	2.54	2.76	2.01	2.54	2.76	2

Stormwater and Sewer Infrastructure

Assets	Consequence Total Score	Area of service loss	Duration of service loss	Cost of damage	Public safety impacts	Economic activities impacts	Public health impacts	Vulnerable populations impacts	Environmental impacts
Sewer Treatment Plant	21.62	2.71	2.61	2.86	2.67	2.43	2.87	2.67	2.8
Stormwater & Sewer Infrastructure	22.13	2.57	2.71	3	2.71	2.57	2.86	2.85	2.86

Transportation Infrastructure

Assets	Consequence Total Score	Area of service loss	Duration of service loss	Cost of damage	Public safety impacts	Economic activities impacts	Public health impacts	Vulnerable populations impacts	Environmental impacts
Airport	17.09	2.91	2.5	2.4	1.7	2.8	1.56	1.44	1.78
Bike & Pedestrian	18.77	2.5	2.18	1.73	2.58	2.08	2.69	2.85	2.17
Marine	17.31	2.67	2.56	2.56	1.63	2.7	1.71	1.71	1.78
Transit/Rail	18.63	2.64	2.36	2.14	2.13	2.47	2.13	2.6	2.15
Road	19.35	2.47	2.36	2.57	2.54	2.29	2.27	2.53	2.33

Waste Management Infrastructure

Assets	Consequence Total Score	Area of service loss	Duration of service loss	Cost of damage	Public safety impacts	Economic activities impacts	Public health impacts	Vulnerable populations impacts	Environmental impacts
EPA Emergency Response - regulated facilities	20.29	2.11	2.11	2.75	2.89	2	2.88	2.78	2.78
Solid Waste Landfill Facilities	19.28	2.6	2.4	2.38	2.2	2	2.4	2.4	2.9
Transfer Stations									
General Solid Waste System: (Composting, Municipal Solid Waste, Recycling)									
Composting	19.22	2.45	2.36	2.4	2.27	2	2.55	2.45	2.73
Municipal Solid Waste									
Recycling									

Water Supply Infrastructure

Assets	Consequence Total Score	Area of service loss	Duration of service loss	Cost of damage	Public safety impacts	Economic activities impacts	Public health impacts	Vulnerable populations impacts	Environmental impacts
Water Supply Infrastructure	22.26	2.92	2.54	2.83	2.85	2.58	3	3	2.54

Natural Assets

Assets	Consequence Total Score	Area of service loss	Duration of service loss	Cost of damage	Public safety impacts	Economic activities impacts	Public health impacts	Vulnerable populations impacts	Environmental impacts
Water Bodies									
Protected Areas, Creeks and Lakes	20.17	2.69	2.64	2.62	2.09	2.42	2.42	2.3	3
Trees and Vegetation									
Trees and Vegetation	20.91	2.62	2.73	2.33	2.54	2.08	2.69	2.92	3
Terrestrial Habitat									
Protected Areas and Habitats	20.17	2.69	2.64	2.62	2.09	2.42	2.42	2.3	3
Parks and Open Spaces									
Community Gardens	20.83	2.62	2.44	2.4	2.37	2.39	2.8	3	2.82
Green/ Community Spaces	20.83	2.62	2.44	2.4	2.37	2.39	2.8	3	2.82
Parks and Playgrounds	21.47	2.78	2.57	2.5	2.38	2.38	2.88	3	3

9. Appendix E: Heat Risk

Richmond Built and Natural Assets

Asset Name	Total City-wide	Units	Heat Risk - Afternoon Mean High Temp >95*			Critical Heat Risk - Afternoon Mean High Temp >96*			
			All Assets at Heat Risk	Assets at Heat Risk in Highly Socially Vulnerable (SV) Areas	Assets Serving SV Groups at Heat Risk Outside Highly SV Areas	All Assets at Highest Heat Risk	Assets at Highest Heat Risk in Most Socially Vulnerable Areas	Assets Serving SV Groups at Highest Heat Risk Outside Most SV Areas	Assets/locations exposed to Critical Heat Risk (Above 96*) in Most Vulnerable SV Areas or serving SV Groups*
Active StormwaterOutfall	1,658	units	468	327	0	0	0	0	0
AM Transmission Towers	3	towers	1	1	0	0	0	0	0
		American Red Cross Chapter Facilities	1	facilities	1	0	0	0	0
		Art District Incentive Zones	0.15	acres	1	0	0	0	0
Bike Infrastructure	71.2	miles	35.7	6.8	0.0	7.4	0.0	0.0	0
		Bikeshare Stations	17	stations	16	1	0	5	0
Biodiesel Plants	1	facilities	1	1	0	0	0	0	0
		Bridges	177	bridges	107	46	0	2	0
CARE Zones	13	zones	12	10	2	3	1	2	*Meadowbridge, *North 25th Street, *Lombardy/Chamberlayne
		Cellular Towers	1	towers	0	0	0	0	0
Cemeteries	17	cemeteries	7	5	0	0	0	0	0
		Chesapeake Bay Protection Area	13,038.3	acres	3,728.30	3,193.3	0.00	31.10	0.00
Childcare Centers	118	centers	61	33	0	6	1	0	Oak Grove Child Care Center - 2200 Fairfax Avenue Richmond, VA 23224
City Historic Districts	45	districts	41	2	0	5	1	0	0
City Historic Sites	29	sites	26	0	0	2	0	0	0
		City Property	966	properties	369	196	0	26	0
Colleges and Universities	4	universities	2	0	0	0	0	0	0
Community Centers	22	centers	13	9	0	1	0	0	0
Community Gardens	5	sites	4	2	0	1	0	0	0

Asset Name	Total City-wide	Units	Heat Risk - Afternoon Mean High Temp >95*			Critical Heat Risk - Afternoon Mean High Temp >96*			
			All Assets at Heat Risk	Assets at Heat Risk in Highly Socially Vulnerable (SV) Areas	Assets Serving SV Groups at Heat Risk Outside Highly SV Areas	All Assets at Highest Heat Risk	Assets at Highest Heat Risk in Most Socially Vulnerable Areas	Assets Serving SV Groups at Highest Heat Risk Outside Most SV Areas	Assets/locations exposed to Critical Heat Risk (Above 96*) in Most Vulnerable SV Areas or serving SV Groups*
Community Unit Plans	110	plans	35	28	0	0	0	0	0
Composting, Recycling, and MSW Facilities	no data points available		0	0	0	0	0	0	0
Convention Center	1	centers	1	0	0	0	0	0	0
Cooling Centers	3	centers	3	1	2	0	0	0	0
Correctional Facilities	3	facilities	3	2	1	0	0	0	0
Courthouses and Court Systems	9	facilities	9	3	0	0	0	0	0
Creeks	31	creeks	10	9	0	0	0	0	0
Dams	2	dams	0	0	0	0	0	0	0
Design Overlay District	3	districts	3	0	0	0	0	0	0
Dialysis Clinics	5	clinics	3	1	2	1	0	1	*DaVita Richmond Community Dialysis - 913 North 25th Street Richmond VA 23233
Electric Power Transmission Lines	53.7	miles	45.2	37.7	0.0	3.9	0.4	0.0	See map for locations
Electric Vehicle Charging Stations	134	stations	60	16	0	17	2	0	
Electrical Substations	1	substations	1	1	1	0.0	0.0	0.0	0
EMS Stations	24	stations	16	7	0	4	0	0	0
Enterprise Zones	4	zones	4	3	1	2	2	0	*III (2746.8 acre), *1(3611.2 acre)
EPA Regulated Facilities	79	facilities	75	52	0	14	1	0	Southern Printing Ink
Fire Stations	21	stations	14	6	0	3	0	0	0
FM Transmission Towers	5	towers	4	1	0	1	0	0	0
Food Pantries	9	pantries	5	3	2	2	0	2	*Northside Outreach Center - 3096 Meadowbridge Road Richmond, VA 23222, *Sara and Steve Bayard Community Kitchen - 1415 Rhoadmiller Street Richmond, VA 23220
Fortune 500 Corporate Headquarters	1	sites	0	0	0	0	0	0	0
Homeless Facilities	5	facilities	5	1	4	2	1	1	Caritas - 1125 Commerce Road Richmond, VA 23224, *Pilgrims Passage - 1500 Sherwood Road Richmond, VA 23220
Hospitals	6	hospitals	4	2	0	0	0	0	0
HUD Multifamily Properties	27	properties	13	12	1	1	0	1	*Highland Park Senior Apartments - 1221 E Brookland Park Blvd, Richmond, VA, 23222
James River Features Islands (Islands)	15	islands	7	5	0	0	0	0	0

Asset Name	Total City-wide	Units	Heat Risk - Afternoon Mean High Temp >95*			Critical Heat Risk - Afternoon Mean High Temp >96*			
			All Assets at Heat Risk	Assets at Heat Risk in Highly Socially Vulnerable (SV) Areas	Assets Serving SV Groups at Heat Risk Outside Highly SV Areas	All Assets at Highest Heat Risk	Assets at Highest Heat Risk in Most Socially Vulnerable Areas	Assets Serving SV Groups at Highest Heat Risk Outside Most SV Areas	Assets/locations exposed to Critical Heat Risk (Above 96*) in Most Vulnerable SV Areas or serving SV Groups*
K12 Public Schools	44	schools	19	9	0	1	0	0	0
Lakes	100	lakes	28	28	0	0	0	0	0
Libraries	13	libraries	10	2	0	0	0	0	0
Local Emergency Operations Centers	1	center	1	0	0	1	0	0	0
Major State Government Buildings	38	buildings	36	1	0	4	0	0	0
Marine Transportation	1	unit	1	1	0	0	0	0	0
Museums	37	buildings	28	1	0	2	0	0	0
National Register Historic Districts	133	Districts	108	22	0	24	4	0	Union Hill; Southern Stove Works; Chesapeake Warehouses; Highland Park Plaza
National Shelter System Facilities	20	facilities	13	3	0	3	0	0	0
NaturalGas Pipeline	1.6	miles	0.2	0.2	0.0	0.0	0.0	0.0	0
Non Gasoline Alternative Fueling Stations	13	stations	12	4	0	3	0	0	0
Nursing Homes	17	homes	11	5	6	1	0	1	*Brook Haven Rest Home - 610 Fourqurean Lane
Parks and Playgrounds	143	parks	72	25	0	7	0	0	0
Pedestrian Infrastructure	no data points available		0	0	0	0	0	0	0
Petroleum Ports	1	ports	1	1	0	0	0	0	0
Petroleum Terminals	9	terminals	9	9	0	0	0	0	0
Police Stations	5	Stations	5	2	0	1	0	0	0
Potential Renewable Energy Sites	13	sites	12	5	0	2	0	0	0
Private Schools	34	schools	13	4	0	3	0	0	0
Public Refrigerated Warehouses	2	sites	2	1	0	0	0	0	0
Public Transit Stations	2	stations	2	0	2	1	0	1	*Greyhound Bus Station - 2910 N Boulevard Richmond VA 23230
Railroad Bridges	27	bridges	14	7	0	0	0	0	0
Rail Lines	159.6	miles	112.5	73.7	0.0	13	0.6	0.0	See map for locations
Religious Centers	74	Centers	42	16	0	5	0	0	See map for locations
Richmond International Airport	0	airports		Outside city limits		0	0	0	0
Roads	1,206.7	miles	640.3	314.0	0.0	80.1	9.9	0.0	0
RRHA Housing	60	locations/parcels	36	31	5	0	0	0	0
Sewer Treatment Plant	1	plants	1	1	0	0	0	0	0
Sheriff Facilities	7	facilities	7	5	0	0	0	0	0

Asset Name	Total City-wide	Units	Heat Risk - Afternoon Mean High Temp >95*			Critical Heat Risk - Afternoon Mean High Temp >96*			
			All Assets at Heat Risk	Assets at Heat Risk in Highly Socially Vulnerable (SV) Areas	Assets Serving SV Groups at Heat Risk Outside Highly SV Areas	All Assets at Highest Heat Risk	Assets at Highest Heat Risk in Most Socially Vulnerable Areas	Assets Serving SV Groups at Highest Heat Risk Outside Most SV Areas	Assets/locations exposed to Critical Heat Risk (Above 96*) in Most Vulnerable SV Areas or serving SV Groups*
SNAP Businesses	193	businesses	110	67	43	19	0	19	See map for locations
Social Services	3	services	3	1	2	0	0	0	0
Solid Waste Landfill Facilities	1	facilities	1	1	0	0	0	0	0
State Federal Historic Sites	156	sites	124	16	0	13	1	0	Southern Stove Works Manchester
Terrestrial Habitat	14	habitats/locations	13	12	0	4	2	0	Agriculture; Southern Atlantic Coastal Plain Mesic Hardwood Forest
Trails	15.94	miles	0.50	0.5	0.00	0.00	0.00	0.00	0
Tree canopy (Street Trees and Trees Other)	120,356	trees	61,396	25,696	0	6,846	1,022	0	See map for areas
Urgent Care Facilities	2	facilities	1	0	0	0	0	0	0
Vegetation/pervious surface cover	no data points available		0	0	0	0	0	0	0
Veteran Health Administration Medical Facilities	2	facilities	1	0	0	0	0	0	0
Voting Stations	67	stations	36	16	0	2	0	0	0
Water Pipes	no data points available		0	0	0	0	0	0	0
Water Treatment Plant	no data points available		0	0	0	0	0	0	0

9. Appendix F: Flood Risk

Richmond Built and Natural Assets

Asset Name	Total City-wide	Units	Flooding Risks				Critical Flood Risk					
			In 100-year Floodplain	In 500-year Floodplain	Affected by >5" Flooding Inundation	Affected by >2" Flooding Inundation	All Assets in 100-year Floodplain and/or >5" Flooding Inundation	Assets at Risk in Highly Socially Vulnerable Areas	Resources Serving SV Groups at Risk Outside Highly SV areas	Assets at Risk in Most Socially Vulnerable Areas	Resources Serving SV Groups at Risk Outside Most SV areas	Assets exposed to Critical Flood Risk in Most Vulnerable SV Areas or serving SV Groups*
Active StormwaterOutfall	1,658	units	731	935	672	698	1064	492	0	154	0	See map for locations
AM Transmission Towers	3	towers	1	1	1	1	1	1	0	0	0	0
		American Red Cross Chapter Facilities	1	facilities	0	0	0	1	0	0	0	0
		Art District Incentive Zones	0.15	acres	0	0	1	1	1	0	0	0
Bike Infrastructure	71.2	miles	6.8	9.0	5.0	5.5	11.3	3.1	0.0	0.59	0.0	See map for locations
		Bikeshare Stations	17	stations	0	1	0	0	0	0	0	0
Biodiesel Plants	1	facilities	1	1	1	1	1	1	0	1	0	Reco Biodiesel Inc
		Bridges	177	bridges	39	48	43	44	62	27	0	15
CARE Zones	13	zones	5	6	13	13	13	11	2	2	11	*Belt Boulevard, *Brookland Park Boulevard, *Fulton Hill, *Hull Street, *Jackson Ward, *Midlothian Turnpike, *North Avenue, *North 25th Street, *Shockoe Bottom, *Swansboro, *Upper Hull Street, Lombardy/Chamberlayne, Meadowbridge,
		Cellular Towers	1	towers	0	0	0	0	0	0	0	0

Asset Name	Total City-wide	Units	Flooding Risks				Critical Flood Risk					
			In 100-year Floodplain	In 500-year Floodplain	Affected by >5" Flooding Inundation	Affected by >2" Flooding Inundation	All Assets in 100-year Floodplain and/or >5" Flooding Inundation	Assets at Risk in Highly Socially Vulnerable Areas	Resources Serving SV Groups at Risk Outside Highly SV areas	Assets at Risk in Most Socially Vulnerable Areas	Resources Serving SV Groups at Risk Outside Most SV areas	Assets exposed to Critical Flood Risk in Most Vulnerable SV Areas or serving SV Groups*
Cemeteries	17	cemeteries	0	0	2	2	2	0	0	0	0	0
		Chesapeake Bay Protection Area	13,038.3	acres	2,501.3	3,265.7	1,703.1	1,918.4	3409.6	1,964.8	0.0	991.4
Childcare Centers	118	centers	0	1	43	56	43	15	0	4	0	North Richmond Branch YMCA; Fairfield Elementary School; Oak Grove Child Care Center; Bethlehem Baptist Church Child Development Center
City Historic Districts	45	districts	1	5	41	43	41	3	0	0	0	0
City Historic Sites	29	sites	0	2	25	27	25	0	0	0	0	0
		City Property	966	properties	22	47	100	136	118	62	0	2
Colleges and Universities	4	universities	0	0	4	4	4	0	0	0	0	0
Community Centers	22	centers	0	0	12	15	12	7	0	2	0	Creighton Court Community Center; Calhoun Community Center and Playground
Community Gardens	5	sites	0	0	0	0	0	0	0	0	0	0
Community Unit Plans	110	plans	45	45	110	110	110	30	0	4	0	See map for locations
Composting, Recycling, and MSW Facilities	no data points available		0	0	0	0	0	0	0	0	0	0
Convention Center	1	centers	0	0	0	0	0	0	0	0	0	0
Cooling Centers	3	centers	0	0	1	1	1	0	1	0	1	*East District Center - 701 North 25th Street Richmond VA 23223
Correctional Facilities	3	facilities	1	2	3	3	3	2	1	2	1	*Medical College Of Virginia Security Ward - 401 North 12th Street Richmond VA 23219, Richmond City Jail - 1701 Fairfield Way Richmond VA 23223, Richmond Juvenile Detention Center - 1700 Oliver Hill Way Richmond VA 23219
Courthouses and Court Systems	9	facilities	0	1	0	0	1	0	0	0	0	0
Creeks	31	creeks	27	31	31	31	31	17	0	4	0	0
Dams	2	dams	0	0	0	0	0	0	0	0	0	0
Design Overlay District	3	districts	0	0	3	3	3	0	0	0	0	0
Dialysis Clinics	5	clinics	0	0	0	0	0	0	0	0	0	0
Electric Power Transmission Lines	53.7	miles	18.9	25.6	15.4	17.2	25.2	21.8	0.0	16.2	0.0	See map for locations

Asset Name	Total City-wide	Units	Flooding Risks				Critical Flood Risk					
			In 100-year Floodplain	In 500-year Floodplain	Affected by >5" Flooding Inundation	Affected by >2" Flooding Inundation	All Assets in 100-year Floodplain and/or >5" Flooding Inundation	Assets at Risk in Highly Socially Vulnerable Areas	Resources Serving SV Groups at Risk Outside Highly SV areas	Assets at Risk in Most Socially Vulnerable Areas	Resources Serving SV Groups at Risk Outside Most SV areas	Assets exposed to Critical Flood Risk in Most Vulnerable SV Areas or serving SV Groups*
Electrical Substations	1	substations	0	0	0	0	0	0	0	0	0	0
Electric Vehicle Charging Stations	134.	stations	2	15	24	27	24	5	0	2	0	1001 E 4th St (ID: 187899), 1001 E 4th St (ID: 188105)
EMS Stations	24	stations	1	2	11	17	11	4	0	2	0	Richmond Fire Department Company 21; Phillip Morris Fire Brigade
Enterprise Zones	4	zones	3	3	4	4	4	4	0	3	0	III (2746.8 acre), III (47.1 acre), 1 (3611.2 acre)
EPA Regulated Facilities	79	facilities	5	18	10	13	14	10	0	4	0	City of Richmond Wastewater Treatement Plant; Bellemeade Power Station; Industrial Alloy Fabricators Inc; Reco Biodiesel, LLC
Fire Stations	21	stations	0	1	10	13	10	3	0	1	0	Richmond Fire Station 21
FM Transmission Towers	5	towers	0	0	0	0	0	0	0	0	0	0
Food Pantries	9	pantries	0	1	0	1	0	0	0	0	0	0
Fortune 500 Corporate Headquarters	1	sites	0	1	0	1	1	1	0	0	0	0
Homeless Facilities	5	facilities	0	1	1	1	1	0	1	0	1	*HomeAgain - 2 East Main Street Richmond VA 23219
Hospitals	6	hospitals	0	0	5	5	5	3	0	0	0	0
HUD Multifamily Properties	27	properties	0	0	2	2	2	1	1	0	2	*Charnwood Forest 4325 Crutchfield St Richmond VA 23225, Blue Ridge Estates - 6507 Sugar Maple Dr. Richmond VA 23225
James River Features Islands (Islands)	15	islands	15	15	15	15	15	8	0	0	0	0
K12 Public Schools	44	schools	0	0	19	29	19	7	0	4	0	Oak Grove Elementary School; John Marshall High School; REAL School; Thomas H Henderson Middle School
Lakes	100	lakes	42	52	88	98	92	39	0	18	0	See map for locations
Libraries	13	libraries	0	0	5	6	5	0	0	0	0	0
Local Emergency Operations Centers	1	center	1	1	1	1	1	0	0	0	0	0
Major State Government Buildings	38	buildings	0	0	18	22	18	0	0	0	0	0
Marine Transportation	1	unit	1	1	0	0	1	1	0	1	0	5001 Deepwater Terminal Rd
Museums	37	buildings	2	8	18	25	18	0	0	0	0	0

Asset Name	Total City-wide	Units	Flooding Risks				Critical Flood Risk					
			In 100-year Floodplain	In 500-year Floodplain	Affected by >5" Flooding Inundation	Affected by >2" Flooding Inundation	All Assets in 100-year Floodplain and/or >5" Flooding Inundation	Assets at Risk in Highly Socially Vulnerable Areas	Resources Serving SV Groups at Risk Outside Highly SV areas	Assets at Risk in Most Socially Vulnerable Areas	Resources Serving SV Groups at Risk Outside Most SV areas	Assets exposed to Critical Flood Risk in Most Vulnerable SV Areas or serving SV Groups*
National Register Historic Districts	133	Districts	24	30	122	129	122	32	0	12	0	Union Hill; Southern Stove Works; Chesapeake Warehouses; Hebrew Cemetery; Pine Camp Tuburculosis Hospital; Richmond Nursing Home; Chesnut Hill-Plateau; Fairmount; Highland Park Plaza; Manchester Industrial; Baker School; American Tobacco Company
National Shelter System Facilities	20	facilities	0	0	11	17	11	5	0	3	0	John Marshall High School; The Calhoun Center; Henderson Middle School
NaturalGas Pipeline	1.6	miles	0.1	0.1	0.1	0.1	0.2	0.0	0.0	0	0	0
Non Gasoline Alternative Fueling Stations	13	stations	0	1	9	9	9	2	0	0	0	0
Nursing Homes	17	homes	0	0	10	11	10	2	8	0	10	*Brookdale Imperial Plaza - 1717 Bellevue Avenue Richmond VA 23227, *Greenfield Residences At Monument Avenue - 501 North Allen Avenue Richmond VA 23220, *Hermitage Methodist Home - 1600 Westwood Avenue Richmond VA 23227, *Humphrey's Retirement Home - 3405 Chamberlayne Avenue Richmond VA 23227, *Jones & Jones LLC - 7804 Forest Hill Avenue Richmond VA 23225, *Madison House - 3212 Chamberlayne Avenue Richmond VA 23227, *The Parkwood - 3003 Parkwood Avenue Richmond VA 23221, *Tiffanie's Manor For Young Adults - 115 North Jefferson Street Richmond VA 23220
Parks and Playgrounds	143	parks	26	33	24	31	47	14	0	2	0	James River Park-Ancarrows Landing; Roy West Park (Washington Park)
Pedestrian Infrastructure	no data points available		0	0	0	0	0	0	0	0	0	0
Petroleum Ports	1	ports	1	1	0	0	1	1	0	1	0	Port of Richmond
Petroleum Terminals	9	terminals	0	4	8	8	8	8	0	5	0	Bukeye Terminals, LLC; Chevron Richmond Terminal; First Energy Corportation; Kinder Morgan Southeast Terminals- Richmond; Kinder Morgan Southeast Terminals- Richmond 2

Asset Name	Total City-wide	Units	Flooding Risks				Critical Flood Risk					
			In 100-year Floodplain	In 500-year Floodplain	Affected by >5" Flooding Inundation	Affected by >2" Flooding Inundation	All Assets in 100-year Floodplain and/or >5" Flooding Inundation	Assets at Risk in Highly Socially Vulnerable Areas	Resources Serving SV Groups at Risk Outside Highly SV areas	Assets at Risk in Most Socially Vulnerable Areas	Resources Serving SV Groups at Risk Outside Most SV areas	Assets exposed to Critical Flood Risk in Most Vulnerable SV Areas or serving SV Groups*
Police Stations	5	Stations	0	0	1	2	1	1	0	0	0	0
Potential Renewable Energy Sites	13	sites	2	3	2	2	3	1	0	1	0	Madison Arms I and II
Private Schools	34	schools	0	0	13	20	13	3	0	1	0	Geara Group/Educational Developmental Center
Public Refrigerated Warehouses	2	sites	0	0	0	0	0	0	0	0	0	0
Public Transit Stations	2	stations	1	1	2	2	2	0	2	0	2	*Main Street Amtrak Station - 1500 E Main St Richmond VA 23219, *Greyhound Bus Station - 2910 N Boulevard Richmond VA 23230
Railroad Bridges	27	bridges	14	19	5	5	15	7	0	2	0	CSX Transportation, Goode Creek; CSX Transportation, Goode Creek
Rail Lines	159.6	miles	48.5	0.0	17.2	21.8	57.7	18.7	0.0	13.7	0.0	See map and reference file for locations
Religious Centers	74	Centers	0	0	34	50	34	9	0	4	0	Saint Kim Taegon Catholic Church; Fifth Street Baptist Church; Bethlehem Baptist Church; Grayland Baptist Church
Richmond International Airport	0	airports		Outside city limits			0	0	0	0	0	0
Roads	1,206.7	miles	28.7	56.7	71.7	84.9	94.3	43.8	0.0	14.9	0.0	See map for locations
RRHA Housing	60	locations/ parcels	1	1	42	55	42	40	2	39	3	See map for locations
Sewer Treatment Plant	1	plants	1	1	0	0	1	1	0	1	0	Anacarows Landing
Sheriff Facilities	7	facilities	0	3	5	6	5	4	0	3	0	Juvenile Detention Center; Oliver Hill Courts Building; Richmond Detention Center
SNAP Businesses	193	businesses	0	6	11	16	11	8	3	1	10	See map for locations
Social Services	3	services	0	0	1	1	1	0	1	0	1	*DSS East District Center - 701 North 25th Street Richmond VA 23223
Solid Waste Landfill Facilities	1	facilities	0	0	0	1	0	0	0	0	0	0
State Federal Historic Sites	156	sites	13	20	119	133	119	17	0	6	0	The Almshouse; Shockoe Hill Cemetery; Pine Camp Tuberculosis Hospital; Southern Stove Works Manchester; Fairmount School; Hebrew Cemetery

Asset Name	Total City-wide	Units	Flooding Risks				Critical Flood Risk					
			In 100-year Floodplain	In 500-year Floodplain	Affected by >5" Flooding Inundation	Affected by >2" Flooding Inundation	All Assets in 100-year Floodplain and/or >5" Flooding Inundation	Assets at Risk in Highly Socially Vulnerable Areas	Resources Serving SV Groups at Risk Outside Highly SV areas	Assets at Risk in Most Socially Vulnerable Areas	Resources Serving SV Groups at Risk Outside Most SV areas	Assets exposed to Critical Flood Risk in Most Vulnerable SV Areas or serving SV Groups*
Terrestrial Habitat	14	habitats/ locations	13	14	14	14	14	13	0	10	0	Open water; Riparian Forest; Agriculture; Southern Atlantic Coastal Plain Mesic Hardwood Forest; Coastal Plain Tidal Swamp; Piedmont-Coastal Plain Large River Floodplain; Dry Oak-Pine Forest; Tidal Salt Marsh- Estatuarine Marsh; Shrubland/Grassland; Laurentian-Arcadian Freshwater Marsh
Trails	15.94	miles	4.7	5.4	0.4	0.5	4.7	2.1	0.0	0	0.0	0
Tree canopy (Street Trees and Trees Other)	120,356	trees	1,739	3,286	8,408	12,019	9597	3,556	0	929	0	See map for locations
Urgent Care Facilities	2	facilities	0	0	2	2	2	0	0	0	0	0
Vegetation/pervious surface cover	no data points available		0	0	0	0	0	0	0	0	0	0
Veteran Health Administration Medical Facilities	2	facilities	0	0	0	0	0	0	0	0	0	0
Voting Stations	67	stations	0	2	31	45	32	12	0	3	0	Calhoun Center; John Marshall High School; 5th Street Baptist Church
Water Pipes	no data points available		0		0	0	0	0	0	0	0	
Water Treatment Plant	no data points available		0	0	0	0	0	0	0	0	0	

Appendix F
Equity Assessment

An Equity-focused Assessment of the City of Richmond's RVAgreen 2050 Planning Process

May 2021

Report Prepared By:

URSP 637: Sustainable Community Development

L. Douglas Wilder School of Government and Public Affairs

Virginia Commonwealth University

Table of Contents

Executive Summary

Prepare to Center Equity

The City of Richmond and the Office of Sustainability's (OOS) efforts to create an equity-informed climate action plan is key to promoting resilient communities. To ensure equitable outcomes, the OOS is prioritizing the needs of historically-marginalized communities through their direct involvement in the planning process. Therefore, preparing all of those involved (city staff, consultants, and community participants) to center equity is vital to the success of this plan. Through our evaluation of the "prepare to center equity" indicator and its four assessment areas (*local government and community readiness, community partners, shared definitions, and budget*), we found both areas of strengths and opportunities for improvements.

Through our evaluation, the OOS and the other involved parties had a clear understanding of the plan, its purpose, and its importance. Their efforts thus far align with the plan's values and show their commitment to producing equitable outcomes. However, we determined opportunities for next steps that the OOS may want to consider throughout the remainder of their planning process. The following recommendations highlighted in this assessment includes:

Recommendations

1. Provide continued and up-to-date equity and climate action planning (CAP) training and education to ensure diverse and inclusive planning processes.
2. Diversify working groups, incorporate youth engagement, and attend existing community meetings to retain newly established frontline community partnerships.
3. Create a checklist for equity self-evaluation to focus on realistic, actionable goals and promote open avenues of communication.
4. Introduce and build capacity for participatory budgeting, as well as supplement budget with grants and philanthropic partnerships.

Capacity Building and Resourcing

We have assessed RVAgreen 2050's climate resilience and community equity vision and implementation in terms of Capacity Building and Resourcing. The United Nations defines capacity building as "the process of developing and strengthening the skills, instincts, abilities, processes and resources that organizations and communities need to survive, adapt, and thrive in a fast-changing world."
To assess this indicator, we drew from best practices and criteria published in the Urban Sustainability Directors Network (USDN) *Community Engagement to Ownership* guide and the *Centering Equity in CAP: Best Practices and Examples*. After analyzing the data on the RVAgreen

2050 process to date, we made the following major recommendations to improve the process moving forward:

Recommendations

1. Through the utilization of outside funding sources, increase community outreach and the process of finding and building community resources - while maintaining existing processes with the Roundtable Members.
2. Maintain existing facilitator and trainers beyond existing contract and enhance the Working Groups with their own dedicated facilitators and trainers to expand capacity building beyond the Roundtable members.
3. Expand upon the equity and sustainability training program founded for the Roundtable community as part of the community outreach mentioned above to spread awareness in disadvantaged communities.
4. Compensation of the facilitators, Roundtable Members, and planned for the Ambassador programs should be expanded to further community outreach trainers and resource finders.

Frame Mission

Preparing to center equity and capacity building represent the preparation work for the planning process and set the stage for the next phase, which is the framing of the mission. For RVAgreen 2050, the framing of the mission is especially important given the focus on equity. Given this focus, different factors, such as community involvement and incorporation of co-benefits, are necessary for the planning process to create meaningful change with respect to narrowing the equity gap.[1] As a result, the team assessed the following factors - equity commitment, co-develop with community, prioritization of co-benefits, and reduction of disparities.

Overall, the Office of Sustainability (OOS) has made great strides in incorporating equity into the RVAgreen 2050 planning process. Among the many positives is the inclusion of the community in the planning process with community-based organizations providing perspective on community priorities and the Racial Equity & Environmental Justice Roundtable (RT) providing the resident and equity lens. It is also notable that the OOS is having this mid-point equity assessment done so that it can further improve its processes. Along the lines of improvement, we also have identified areas of opportunities for the OOS to consider, and they are as follows:

[1] Urban Sustainability Directors Network (USDN). (2017). *Guide to Equitable, Community-Driven Climate Preparedness Planning*. Urban Sustainability Directors Network. https://www.usdn.org/products-climate.html#GuideClimate

Recommendations

1. As part of outreach efforts, the OOS may want to consider re-engaging with community-based organizations to ensure sufficient engagement with frontline communities.
2. The OOS may want to consider highlighting to the public the broader equity focus throughout the government and consider creating a cross-departmental group to keep equity efforts going after this planning process.
3. The OOS may want to consider surveying RVAgreen 2050 participants, especially city staff, in order to determine the equity knowledge that was gained from the process.
4. The OOS may want to consider creating a charter that outlines the Roundtable's roles/responsibilities with respect to the remaining phases of the process.
5. The OOS may want to consider quantifying co-benefits in order to focus on the strategies that will have the greatest impact.

Equitable Decision-making

The Urban Sustainability Directors Network (USDN) identifies *equitable decision-making* as an essential step in the process of community empowerment over the planning process, and calls for a "clear and transparent decision-making process" that cultivates power sharing, transparency, and accountability between the community, government actors, and experts.[2] It is rooted in the premise that decision-making power should be enjoyed by those who will be affected by the decisions that are made, and is a way to clearly recognize that all values and interests are important. In other words, it is "planning *with* stakeholders rather than *for* stakeholders."[3]

We find that overall, city staff, facilitators, and community Roundtable members appear to have similar expectations for how decisions are made for RVAgreen 2050. Our assessment of the RVAgreen 2050 process finds that equitable decision-making in planning is supported through the consideration of three assessment indicators: power sharing, transparency and accountability. The Office of Sustainability has made public commitments to honor community priorities and include community perspectives in the planning process, which creates a shared and transparent framework. The public commitments also ensure that the Office is accountable for centering equity for the duration of the plan's development. Even having a dedicated

[2] Urban Sustainability Directors Network (USDN). (2019). *From community engagement to ownership: Tools for the field with case studies of four municipal community-driven environmental and racial equity committees.* Urban Sustainability Directors Network, p.14. https://www.usdn.org/uploads/cms/documents/community_engagement_to_ownership_-_tools_and_case_studies_final.pdf

[3] Roseland, M. (2000). Sustainable community development: Integrating environmental, economic, and social objectives. *Progress in Planning*, 54(2), 73-132. p. 107. DOI: 10.1016/S0305-9006(00)00003-9

Roundtable, and granting it a key authoritative role within the process, highlights the Office's commitment to a shared-decision making model. However, based on our interviews, document analysis, and best practices in equitable climate action planning, we suggest that the Office of Sustainability implement the following recommendations to ensure continued centering of shared decision-making in RVAgreen 2050:

Recommendations

1. Continue to share decision-making power with stakeholders throughout the plan adoption and implementation phase in 2022 and seek ways to ***engage new citizen-participants in this process*** that represent new demographics, geographies, and social networks (e.g., beyond existing relationships)

2. Collaboratively develop and publish strategies to address how the Office plans to continue to train and support Roundtable members during the engagement phase and how they will ***catalog and communicate*** this community feedback

3. Define and publish a series of ***equity-related indicators*** to center the plan's implementation around continued equity, particularly given that no such set of evaluation criteria exist for the planning process

Build Support

Building public support for the plan throughout the planning process pushes city staff to better understand the community they are working with. As has often been the case in planning, power can be disproportionately in the hands of resourceful developers and industries who do not hold the same values for the community as do residents. Working with the community to elevate their voices is of great importance, as "trusting relationships translate ideas into action and grease the wheels of change" according to the USDN, thus building momentum for community focused, equitable progress.[4]

RVAgreen staff have addressed the need for community trust and support through the implementation of a Roundtable of community members specially trained in equity and sustainability. This effort by the city has been evaluated based on six assessment indicators: mutual learning, participant needs, setting a realistic timeline, transparency, diversity, and engagement. The Roundtable members were tasked with being representatives of their community, teaching and learning from staff and facilitators to best understand how to

[4] Urban Sustainability Directors Network (USDN). (2019). *From community engagement to ownership: Tools for the field with case studies of four municipal community-driven environmental and racial equity committees.* Urban Sustainability Directors Network, p.19.

approach equity centered sustainability in Richmond. The members are demographically reflective of their community and were selected primarily based on their ability to meaningfully interact with their neighbors. While the planning process thus far has resulted in new information and ideas for the city from Roundtable members, there are possible improvements for the future. Because of this, the following recommendations have been provided:

Recommendations:

1. As RVAGreen2050 starts to reach out to community members to build support throughout the community, consider alternative ways of reaching community members where they are and building relationships with well established community leaders.
2. While equity was understood to be a priority by the Office of Sustainability, Facilitators, and Roundtable members, that was not always the case with working group members. Greater equity training for working group members would prevent ideas incongruent with the concept of centering equity in the plan from slowing down the process while also promoting higher quality ideas.
3. The RVAGreen2050 team should develop an additional Climate Equity Implementation guide that provides a framework for evaluating the actions in relation to the objectives that were developed.

Section I: Introduction

Centering Equity and RVAgreen 2050

In response to growing concerns of damaging effects caused by climate change, the City of Richmond's Office of Sustainability (OOS) is developing the RVAgreen 2050 plan. Building on the city's sustainability plan adopted in 2012, RVAgreen 2050 takes an equity approach and aims to center historically marginalized communities of color.[5]

The OOS recognizes how Richmond's history of racism and structural inequalities have exacerbated climate concerns for largely Black and Latinx communities.[6] Historic planning often excluded vulnerable groups from decision making processes, having lasting adverse effects still being felt today. In recent years, planners have recognized the importance of including community members through thoughtful engagement processes.

Given the historic inequities in urban planning, the OOS understands the importance of involving impacted community members throughout the entire decision making process. One way to ensure that planning processes are inclusive is through the creation of the Racial Equity and Environmental Justice Roundtable (RT). The RT consists of 13 City of Richmond residents, with varying demographics and backgrounds. The RT members utilize their expertise to advocate for marginalized communities and help to guide the planning processes to ensure they are equitable.

Scope of Work, Approach and Limitations

The RVAgreen 2050 staff requested that the Virginia Commonwealth University Sustainable Community Development Spring 2021 service learning course complete an external equity assessment of the process to date. The evaluation will assess the equitability of the current engagement processes and to make recommendations for improvement.

The evaluation is informed by RVAgreen 2050 documents, as well as evidence gathered from interviews of City Staff, Facilitators/Trainers, and Resident Roundtable Members. Additionally, this assessment often refers to the Urban Sustainability Directors Network's (USDN) framework for community engagement, which recognizes the exclusivity of past planning practices by encouraging processes to shift towards community ownership to close equity gaps.[7]

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[5] City of Richmond. (n.d.). What is RVAgreen 2050? RVAgreen 2050. https://www.rvagreen2050.com/what-is-rvagreen-2050.

[6] Ibid.

[7] Urban Sustainability Directors Network (USDN). (2019). From community engagement to ownership: Tools for the field with case studies of four municipal community-driven environmental and racial equity committees. Urban Sustainability Directors Network. https://www.usdn.org/uploads/cms/documents/community_engagement_to_ownership_-_tools_and_case_studies_final.pdf

Additionally, this report separately evaluates the contributions of city staff (RVAgreen 2050 Community Engagement Coordinator Kendra Norrell and Sustainability Coordinator Brianne Fisher), third-party facilitators and trainers (Ebony Walden, Ebony Walden Consulting and Matthew Freeman, Dialectix Consulting), and anonymous Roundtable residents in terms of these assessment area.

Section II: Indicators and Assessment

A. Prepare to Center Equity

In response to growing concerns of damaging effects caused by climate change, the City of Richmond's Office of Sustainability (OOS) is developing the RVAGreen 2050 plan. Building on the city's sustainability plan adopted in 2012, RVAgreen 2050 takes an equity approach and aims to center historically marginalized communities of color.[8]

In this section, we evaluate how the OOS *prepared to center equity* throughout its approach to climate change planning thus far. To do so, we identify four different assessment areas: **1) local government and community readiness, 2) community partners, 3) shared definitions, and 4) budget.** We analyzed these four criteria to better understand how the OOS can build on what is currently working and to determine opportunities for next steps.

Overview of Assessment Indicators

To ensure that the outcomes of the RVAgreen 2050 plan represent the needs of frontline community members, it is important that all participants are prepared to center equity. This preparation requires government and community readiness, strong community partners, clear understanding of shared definitions, and adequate and properly allocated funding sources. All four indicator assessment areas are necessary to promote equitable outcomes.

Assessment Indicator	Definition
Government and Community Readiness	*Commitment from both government and community participants to work collaboratively towards addressing systemic inequalities as they relate to climate change concerns.*
Community Partners	*Community partnerships are collaborative relationships between willing entities formed to address shared objectives.*
Shared Definitions	*Shared definitions reinforce mutual understanding of the guiding principles in a planning process.*
Budget	*A municipal budget is the projected financial operating plan and accounts for expected revenues and allocates resources to particular expenditures.*

[8] City of Richmond. (n.d.). What is RVAgreen 2050? RVAgreen 2050. https://www.rvagreen2050.com/what-is-rvagreen-2050.

Building on What's Working

Government and Community Readiness

City staff members had a strong and consistent understanding of equity as it relates to climate change. Through their research, they found that climate change affects some more than others, and specifically, how low-income communities of color are disproportionately impacted by climate change. To understand how to involve frontline communities they pulled together best practices for centering equity in climate action plans.[9] After assessing these best practices they created the RVAgreen 2050 Roundtable (RT), working groups, and ambassador program. These groups represented Richmond residents and technical professionals, both equipped with specific expertise valuable to the planning process.[10] Additionally, the OOS provided equitable community engagement and decision making training from Virginia Community Voice (VCV) to better prepare both government officials and community participants.[11]

In addition to hiring VCV, the OOS brought on facilitators/trainers with expertise in racial equity to provide guidance during meetings that included city staff, RT members. These experts helped the OOS develop criteria for the selection of RT participants, with city staff having the final word.[12] Overall, the facilitators/trainers had a clear understanding of their role as consultants and to help all those involved understand why equitable decision making is important and to prepare them to thoughtfully engage with underserved communities.[13]

RT members played a vital role in preparing local government officials and community members to center equity throughout the planning process. Members clearly understood their role as advocates for vulnerable community members.[14] In addition to their lived experiences, RT members received equity training, as well as additional reading/assignments from facilitators and trainers to ensure they were prepared to engage with underserved communities.[15]

[9] Fisher, B. & Norell, K. (2021, February 15). Personal Interview.

[10] Virginia Community Voice. (n.d.). Virginia Community Voice Blueprint. https://vacommunityvoice.org/blueprint.

[11] Fisher, B. & Norell, K. (2021, February 15). Personal Interview.

[12] Walden, E. & Freeman, M. (2021, February 22). Personal interview.

[13] Ibid.

[14] Anonymous (P1). (2021, March 8). Personal interview. Anonymous (P2). (2021, March 10). Personal interview. Anonymous (P3). (2021, March 15). Personal interview. Anonymous (P4). (2021, March 22). Personal interview.

[15] Walden, E. & Freeman, M. (2021, February 22). Personal interview.

Community Partners

The USDN recognizes the vital role genuine community partnerships play in collaborative governance and the overall success of community engagement processes.[16] Given planning's historic pitfalls of excluding disadvantaged populations, these efforts are both extremely important and challenging. Trust is the foundation of any relationship and even more important for those who have felt their voices are often unheard. Unequal power dynamics have left the seemingly 'powerless' feeling underrepresented or misrepresented, having lasting effects on the community.[17] The RVAGreen 2050 plan aims to center community voices to promote equitable decision-making processes. The following section highlights how current community partnerships are centering equity in the plan, what is working, and what should be built upon for the remainder of the planning process.

The OOS has been rigorous in their efforts to center equity in the RVAgreen 2050 CAP. The first contacts the OOS reached out to for guidance in community engagement were prior connections within community-based non-profits. The feedback OOS received from these organizations was that they needed to go directly to the community even during these initial steps[18].

Since centering equity and Climate Action Planning are new to Richmond, the OOS enlisted Virginia Community Voice (VCV) to provide their racial equity and community engagement expertise to facilitate the pre-planning process and help recruit the community RT for racial and environmental justice[19]. The facilitators helped the OOS develop an application and identify residents in frontline communities for the RT. There was also an application process for recruiting for five technical working groups which included city workers and professionals in the fields of, transportation, environmental work, building and energy, waste, and community work. Thirteen RT members were selected and a total of 125 professionals were recruited for the five working groups[20]. VCV facilitated trainings with community experts (RT), technical experts (Working groups), and city staff on centering equity in CAP so that everyone understood that this was a community driven effort with particular attention to community voices that had been disenfranchised by past planning initiatives[21].

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[16] USDN. (2019). *From Community Engagement to Ownership: Tools for the Field with Case Studies of Four Municipal Community-Driven Environmental & Racial Equity Committees*. Urban Sustainability Directors Network. https://www.usdn.org/uploads/cms/documents/community_engagement_to_ownership_-_tools_and_case_studies_final.pdf

[17] USDN. (2019). *From Community Engagement to Ownership: Tools for the Field with Case Studies of Four Municipal Community-Driven Environmental & Racial Equity Committees*. Urban Sustainability Directors Network. https://www.usdn.org/uploads/cms/documents/community_engagement_to_ownership_-_tools_and_case_studies_final.pdf

[18] Fisher, B. & Norell, K. (2021, February 15). Personal Interview.

[19] Ibid.

[20] RVAgreen 2050 PLANNING Process: Richmond. (n.d.). Retrieved March, 2021, from https://www.rva.gov/sustainability/rvagreen-2050-planning-process

[21] Walden, E., & Freeman, M. (2021, February 22). *RVAgreen 2050 Interview* [Video].

The round table is the community contact and has the last say on proposed planning strategies put forth by working groups. The RT members are well connected in their communities and are passionate about speaking out for their neighbors and improving their part of the city. An example that came up in several interviews with RT members was that many RT members found they had to remind working groups to keep language clear for those who do not work in the field and are unfamiliar with sustainability terms. In addition, it is the RT members task to explain to their communities how climate change affects everyday life and why they should care[22]. For example, lack of trees and open space in low-income and inner city neighborhoods has resulted in the heat island effect, which can raise utility bills and decrease air quality.

Another tool the OOS is using to increase community participation is the Ambassador Program which uses an online platform. Ambassadors are offered an online training and community engagement toolkit. They are encouraged to host at least three meetings with their communities and provide feedback to the OOS. This is beneficial in creating avenues for participation during the pandemic but can also be seen as exclusive to community members that do not have internet resources. The OOS has identified this issue in equity and provides a link for suggestions on how to improve the process[23].

Shared Definitions

Broken down by stakeholder group, this section gives an overview of what is working well in pursuit of RVAgreen 2050's goals as they relate to definitions of guiding terms for the process. Thus far, city staff have done a good job differentiating between types of equity and how they relate to sustainability planning in various respects. Staff identified procedural equity, distributional equity, and structural equity as three types of equity that the participants should consider as they work through the process.[24] In addition, the city staff have also promoted a definition of sustainability that goes beyond serving only environmental outcomes to consider wider interpretations of sustainability that include equity, environmental justice, and socially-oriented sustainability issues.[25]

The facilitators of the RVAgreen 2050 process are tasked, among other things, with helping participants, inclusive of city staff, form an equity lens and actually conduct the planning process in a way that is procedurally equitable. They have accomplished this through continuous equity training sessions and through encouraging reflection and self-assessment for

[22] Anonymous (P1). (2021, March 8). Personal interview. Anonymous (P2). (2021, March 10). Personal interview. Anonymous (P3). (2021, March 15). Personal interview. Anonymous (P4). (2021, March 22). Personal interview.

[23] Virtual ambassador program. (n.d.). Retrieved March 29, 2021, from https://www.rvagreen2050.com/ambassador-program

[24] Fisher, B. & Norell, K. (2021, February 15). Personal Interview.

[25] Agyeman, J. (2008). Toward a "just" sustainability? *Continuum: Journal of Media & Cultural Studies*, *22*(6), 751–756; Roseland, M. (2000). Sustainable community development: Integrating environmental, economic, and social objectives. *Progress in Planning*, *54*, 73–132.

equity among participants.[26] They aim to encourage participants, inclusive of city staff, to relate to one another in a way that is authentic and transparent, as well as promote mutual learning.[27] Authenticity, transparency, and mutual learning during the planning process all support the guiding principle of procedural equity. Furthermore, the facilitators have worked to avoid generalizations in representing issues specific to Richmond in the group. Rather than talking about participation numbers or vague sustainability issues, they have kept the conversation centered on potentially-transformative practices for sustainability in Richmond and raised issues for Richmond specifically, such as demographic representation in planning participation.[28]

Part of what RT members have done well is their continuous reflection on the process itself and whether it is being carried out in a way that is procedurally equitable. This sometimes means that more confident participants step in to advocate for people who might not be as confident sharing their views in a group setting in order to make sure that everyone has an opportunity to voice their concerns.[29] In other situations, they might look to specific members to relate discussion topics to their lived experiences. Furthermore, the RT reinforces among its members the same view of sustainability that the city staff have emphasized as part of the plan, and they seek to use equity as a lens through which to evaluate sustainability and environmental justice.[30]

Budget

To expand capacity and ensure the planning process is equitable and authentic, financial investment is necessary. It is important that the budget is inclusive of both city staff needs and fair compensation for participants**.**Thus far, city staff disclosed the OOS works within a total budget of $50,000 for each fiscal year, with the forty percent of funding dedicated to RT member stipends[31]. Given the considerable amount of time and energy RT members put into this process, compensation practices should align with the plan's values of inclusion and equity.[32] Additionally, RT members can request further funding for materials necessary for

[26]Walden, E. & Freeman, M. (2021, February 22). Personal interview.

[27] Ibid.; USDN. (2019). *From Community Engagement to Ownership: Tools for the Field with Case Studies of Four Municipal Community-Driven Environmental & Racial Equity Committees*. Urban Sustainability Directors Network. https://www.usdn.org/uploads/cms/documents/community_engagement_to_ownership_-_tools_and_case_studies_final.pdf

[28]Walden, E. & Freeman, M. (2021, February 22). Personal interview.; USDN. (2019). *From Community Engagement to Ownership: Tools for the Field with Case Studies of Four Municipal Community-Driven Environmental & Racial Equity Committees*. Urban Sustainability Directors Network. https://www.usdn.org/uploads/cms/documents/community_engagement_to_ownership_-_tools_and_case_studies_final.pdf

[29] Anonymous (P2). (2021, March 10). Personal interview.

[30] Roseland, M. (2000). Sustainable community development: Integrating environmental, economic, and social objectives. *Progress in Planning*, *54*, 73–132; Anonymous (P2). (2021, March 10). Personal interview.

[31] Fisher, B. & Norell, K. (2021, March 30). Personal Interview.

[32] USDN. (2019). From Community Engagement to Ownership: Tools for the Field with Case Studies of Four Municipal Community-Driven Environmental & Racial Equity Committees. Urban Sustainability Directors Network.

participation.[33] Fiscal and managerial resources shape sustainability action in early stages and are essential to the implementation process. Lack of funding is especially detrimental to social equity initiatives.[34]

City staff's efforts to secure a $10,000 grant to use toward racial equity training revealed their ability to prepare to center equity from the very start of their planning process[35]. In addition to these efforts, allocating these resources to hiring VCV, a community-based organization, aligns with the plan's values.[36] Allocating funds to hire racial equity experts (facilitators/trainers) and outside contractors to complete technical aspects (i.e., greenhouse gas modeling), the OOS actions were aligned with the plan's values.

Summary Table

What is working well with respect to RVAgreen 2050's process in preparing to center equity?			
	Office of Sustainability	Consultative Facilitators	Roundtable Members
Government and Community Readiness	• Engaged in pre-planning efforts that included research, data collection, and capacity building. • Created the RT, working groups, and ambassador program all aimed to center equity. • Provided equity training for all those involved with the planning process.	• Helped city staff develop the RT selection criteria to ensure members are representative of Richmond's demographics. • Used their racial equity expertise to facilitate and train city staff and participants on racial and environmental justice. • Guided discussions in meetings to ensure that all voices were being heard and considered.	• Utilized their lived experiences to advocate for the needs of historically marginalized groups more susceptible to climate change impacts. • Received equity training to understand how to thoughtfully and effectively engage with low-income communities of color. • Completed assigned readings and homework aimed to educate members on racial and environmental justice.

[33] Fisher, B. & Norell, K. (2021, February 15). Personal Interview.

[34] Liao, L., Warner, M. E., & Homsy, G. C. (2020). When do plans matter? Journal of the American Planning Association, 86(1), 60-74. doi:10.1080/01944363.2019.1667262

[35] Fisher, B. & Norell, K. (2021, February 15). Personal Interview.

[36] Virginia Community Voice. (n.d.). Virginia Community Voice Blueprint. https://vacommunityvoice.org/blueprint.

Community Partners	• Utilized established community connections to spread the word about the RVAGreen 2050 plan and to make useful connections throughout the planning process. • Formed the RT, working groups, and ambassador program all intended to work with community partners to center equity throughout the planning process.	• Directed the plan's goal of centering equity from the beginning by training RT community experts, technical experts, and city workers. • Guided city staff and community members in engagement strategies and adaptive leadership.	• Well connected in the City of Richmond and to specific neighborhood organizations in each city district. • Utilized lived experience, as well as knowledge gained from training and meetings to engage with working groups.
Shared Definitions	• Acknowledged varying types of equity: procedural, distributional, and structural. • Took a holistic view of urban sustainability and featured equity as an integral component.	• Helped both city staff and RT members model, conduct, and assess for equitable community engagement practice through training sessions and reflection. • Encouraged authenticity, transparency, and mutual learning between all involved parties as part of an equitable public process. • Avoided generalizing in dialogues with staff and RT; speaking directly to Richmond's racist legacies and planning practices.	• Reflected on whether processes and discussions conducted within the RT or working groups are carried out in an equitable way, using previously-established definitions of equity. • Viewed sustainability issues through the larger lens of social justice and equity.
Budget	• Allocated the majority of the budget to RT member stipends. • Secured a $10,000 grant for equity training and hired Virginia Community Voice (VCV). • Utilized funds to further engage with community members (i.e., yard signs, survey creation, and website creation).	• Budgeted funds to hire consultants/facilitators whose expertise were in racial equity training. • Smaller consulting contracts were given for technical aspects of the plan (i.e., greenhouse gas modeling).	• Budget included funds that compensated RT members for their efforts. • Can request funds from city staff to pay for any additional material necessary.

Opportunities for Next Steps

Government and Community Readiness

Given recurring comments made across all interviews regarding the lack of diversity within the working group,[37] it is important to consider how this will impact their planning process and overall government and community readiness. To ensure the next phase of community outreach efforts are authentic and equitable, we recommend that city staff consider continued education/training to help local government officials and community participants feel prepared and supported.[38] The Providence REJC (Race and Environmental Justice Committee) case study offered in the USDN framework highlights the important role racial equity training played in the success of their outcomes.[39] Through offering multiple trainings, the REJC was able to 1) build shared language and 2) support community members and staff.[40]

To do so, city staff should reassess their capacity to further engage with a diverse group of community members that are representative of Richmond's most vulnerable residents. While expanding capacity does indeed require investment, to make structural changes and cultural shifts it is needed.[41] How will city staff expand capacity to further reach low-income communities of color? For example, city staff may want to consider their communication efforts (i.e., social media or advertisements), how it impacted their lack of diversity, and how to further reach frontline community members.

Through our interviews with RT members it became clear that tension between technical experts and community members was present in meetings. For example, one interviewee referred to this tension as a push and pull between socially oriented language and technical language; they stated that in their experience the city preferred to use technical language that does not extend to everyone.[42] We recommend that facilitators/trainers provide further guidance to ensure that conversations are not dominated by a singular voice or approach to include lay people's terminology and limit technical jargon. Additionally, up to date equity training that is easily related to experiences in the city of Richmond is important.

RT members must be supported and empowered to share their unique perspectives and expertise. However, during our interviews with members they rarely referred to themselves as experts; one interviewee explained how they felt hesitant to take ownership of the plan and felt it was hard to give input when discussions were dominated by technical experts; specifically, they were dominated by white men.[43] We recommend that all RT and working group members are aware of the value of community participant's experiences to produce

[37] Anonymous (P1). (2021, March 8). Personal interview; Anonymous (P2). (2021, March 10). Personal interview; Anonymous (P3). (2021, March 15). Personal interview; Anonymous (P4). (2021, March 22). Personal interview.

[38] Urban Sustainability Directors Network (USDN). (2019). From community engagement to ownership: Tools for the field with case studies of four municipal community-driven environmental and racial equity committees. Urban Sustainability Directors Network. https://www.usdn.org/uploads/cms/documents/community_engagement_to_ownership_-_tools_and_case_studies_final.pdf

[39] Ibid.

[40] Ibid.

[41] Ibid.

[42] Anonymous (P4). (2021, March 22). Personal interview.

[43] Anonymous (P3). (2021, March 15). Personal interview.

equitable outcomes. Concerns presented by lay people should be thoughtfully considered and addressed by technical experts.

Community Partners:

From the start the OOS was determined to strengthen existing community partnerships and create new ones throughout the RVAgreen 2050 planning process. This was evident from their very first community outreach effort to better understand how the community felt about their approach and if it was equitable. However, given the major interruptions due to the COVID-19 pandemic, community outreach was relatively low in the pre-planning efforts. Given these barriers, it is important that the OOS is aware of potential equity concerns in their planning processes to better prepare for the remainder of their efforts. The following section provides insight on the various opportunities for next steps.

This report recommends finding avenues to retain RT members and new frontline community partners by connecting them to other city processes. This can foster leadership skills for long-term, equitable, and community driven planning outcomes. Examples of this include connecting community members to training opportunities and inviting them to participate in other municipal planning processes. The USDN case study of Seattle, Washington's Environmental Justice Committee (EJC) explains that the committee's role is to create leadership pathways for impacted community members. The EJC is clear in its goal to go beyond information sharing and creating a permanent bridge for their communities to effect municipal planning.[44]

Another recommendation is to build youth partnerships with public schools and existing local youth programs in frontline communities. Youth partnerships can play a critical role in sustainability efforts by helping to cultivate health, social, and environmental equity in future generations. The benefits include, greater exposure to green space, increased opportunities for social interaction and connectedness, mentorship, educational opportunities, a greater sense of self-reliance, and a favorable perception for control in life.[45] Growing Up Boulder (GUB) is an example of a partnership organization between the city of Boulder, the Boulder Valley School District, and the University of Colorado's Community Engagement Design and Research Center (CEDaR)[46]. The Great Green Neighborhoods project came about when the city's community planning and sustainability staff was considering child friendly affordable housing. The project focused on Athens's Court, a low-income housing site across from Boulder High School that was in need of renovations and flood protection[47]. GUB recruited a local third grade class and

[44] Urban Sustainability Directors Network (USDN). (2019). *From community engagement to ownership: Tools for the field with case studies of four municipal community-driven environmental and racial equity committees.* Urban Sustainability Directors Network.

[45] Jennings, V., Baptiste, A., Osborne Jelks, N., & Skeete, R. (2017). Urban green space and the pursuit of Health equity in parts of the United States. *International Journal of Environmental Research and Public Health, 14*(11), 1432. doi:10.3390/ijerph14111432

[46] Our Team. GROWING UP BOULDER. (n.d.). http://www.growingupboulder.org/our-team.html.

[47] Great Neighborhoods. GROWING UP BOULDER. (n.d.). http://www.growingupboulder.org/great-neighborhoods.html.

Boulder High School students, some of whom lived in Athens Court. GUB coordinated field trips to one of Boulders award winning housing sites. The younger students were encouraged to draw, make housing models, and express their opinions through writing. High school students learned about sustainable housing design and flood mitigation and created a presentation for city staff[48]. The third graders wanted a variety of natural and built play spaces woven throughout the site as well as a variety of housing designs and colors. The high school students were interested in gathering spaces, affordable food spots, and expressed concerns for personal safety suggesting better lighting and car safety features. A University of Colorado course focused on green neighborhood design worked with students and city officials. The plan also included natural strategies for flood mitigation[49]. This project illustrates how youth partnerships can bring frontline community voices to inform equitable climate action planning.

Finally, facilitators have played an essential role in getting city workers, professional experts, and community RT members on the same page in centering equity during the pre planning phase of RVAgreen 2050. As new partners become involved in RVAGreen 2050 it would be invaluable to keep facilitators and consultants involved in the next stages so that they can continue to assess and improve strategies and keep everyone on the same page throughout the plan's development and implementation.

Shared Definitions

Broken down by stakeholder groups, this section gives an overview of opportunities for next steps in pursuit of RVAgreen 2050's goals as they relate to essential definitions guiding the process. In the previous shared definitions section, we identified that city staff had been successful in reinforcing a wide view of equity and a view of sustainability that incorporates equity. This is a good start, but to improve, it would be beneficial to encourage the participants to assess equity, sustainability, and progress toward goals from their own points of view. To accomplish this, city staff should consider working with facilitator/trainers and RT members to create an equitable planning checklist that represents the baseline goals for procedural equity in the planning process as well as progress toward implementation.[50] Furthermore, once everyone works together to create this checklist, city staff should encourage participants to assess the process themselves using the checklist. If concerns are raised by participants, consider ways to revisit those concerns in group discussion.[51] Examples of a self-evaluation

[48] Ibid.

[49] Ibid.

[50] Urban Sustainability Directors Network (USDN). (2019). *From community engagement to ownership: Tools for the field with case studies of four municipal community-driven environmental and racial equity committees.* Urban Sustainability Directors Network. https://www.usdn.org/uploads/cms/documents/community_engagement_to_ownership_-_tools_and_case_studies_final.pdf

[51] Ibid.

handout can be readily adapted from other cities' efforts.[52]

We have already noted that facilitators have been successful in setting the stage for equitable planning through continuous training and encouraging participants to have open and honest relationships with one another. However, the facilitators will be confronted with different issues and questions as the process moves forward through outreach phases and toward implementation phases. We suggest that facilitators encourage participants to recall learning from equity training sessions as they guide participants through development and implementation of best practices.[53] This recall process may already be the trajectory of the facilitators, who have stated that they try to ask how ideas from training sessions relate back to outreach that RT members are doing and how conversations about equity and sustainability play out on the ground.[54] We view this as essential to upholding consistent best practices, as defined earlier through training sessions.

Previously, we touched on the RT doing excellent work in assessing equitable procedure in the discussion groups and upholding views of equity and sustainability that are consistent with the goals of the plan. However, we also suggest that the RT members reflect on the behavior of participants and the discussion quality throughout the process. Some RT members have suggested that the quality of conversation has decreased due to certain agents dominating conversation or undermining equity discussions.[55] In a situation like this, we ask that RT members consider why discussion might have deteriorated and consult with facilitator/trainers and city staff to make a plan to bridge gaps.[56] Furthermore, RT members we interviewed also suggested that there were situations in which participants may have had an idea to contribute but did not feel comfortable sharing with the group; in this particular scenario, another RT member advocated for them.[57] We ask that, in light of this, RT members generally reflect on other members' comfort levels and respectfully prompt them to contribute if they might have something to add.[58] These suggestions are aimed at upholding procedural equity as a guiding principle, as it has been identified and defined by the city staff.

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[52] Partners for Places. (2018). *A Guide to Community-Centered Engagement in the District of Columbia* (p. 80). Georgetown Climate Center. https://www.georgetownclimate.org/files/report/CEG-TechnicalAppendix-10-2018-FINAL.pdf

[53] Urban Sustainability Directors Network (USDN). (2019). *From community engagement to ownership: Tools for the field with case studies of four municipal community-driven environmental and racial equity committees.* Urban Sustainability Directors Network. https://www.usdn.org/uploads/cms/documents/community_engagement_to_ownership_-_tools_and_case_studies_final.pdf

[54] Walden, E. & Freeman, M. (2021, February 22). Personal interview.

[55] Anonymous (P2). (2021, March 10). Personal interview.

[56] Urban Sustainability Directors Network (USDN). (2019). *From community engagement to ownership: Tools for the field with case studies of four municipal community-driven environmental and racial equity committees.* Urban Sustainability Directors Network. https://www.usdn.org/uploads/cms/documents/community_engagement_to_ownership_-_tools_and_case_studies_final.pdf

[57] Anonymous (P2). (2021, March 10). Personal interview.

[58] Urban Sustainability Directors Network (USDN). (2019). *From community engagement to ownership: Tools for the field with case studies of four municipal community-driven environmental and racial equity committees.* Urban Sustainability Directors

Budget

The OOS recognizes the important role budgeting plays in a successful planning process. Specifically, that sustainability plans rely on a sufficient budget to provide adequate resourcing for community engagement[59]. It is important to note that while under typical circumstances sustainability budgets are severely lacking in most cities. This lack of funding has been compounded further by the COVID-19 pandemic that has contributed to substantial loss of city revenue. We kept the extenuating circumstances of the global pandemic and how that impacted resources while forming the following recommendations for next steps.

We believe an opportunity for next steps includes supplementing budgets by continuing to research and apply for grants, as well as connect and establish long-term philanthropic partnerships to resource community organizational. Philanthropic and government partnerships are becoming more common and are aligning with an equity and inclusion approach[60]. The Council of Michigan Foundations (CMF) is a state agency that connects localities to philanthropic organizations funding and grants for local jurisdictions[61]. Michigan has introduced a new equity centered philanthropic resource initiative called Truth, Racial, Healing and Transformation (TRHT). The foundation has connected grant funding to four cities one of which is Kalamazoo[62]. The Kalamazoo TRHT programming is led by a team of 15 community members[63]. So far, their initiatives include legal sector engagement and cultural awareness training for police cadets training to be local police officers. The training focuses on relationship building, reviewing discriminatory laws, criminal laws, and public policies, and recommending solutions to the just application of law[64]. The team also works with communities on housing issues funded by a grant from the Government Alliance on Racial Equity (GARE) and has created a coalition for inclusive communities using a grant from Community Foundation Leads (CFLeads)[65]. The OOS does not currently have a state agency to help connect with philanthropic partners and grants research but still many foundations seem eager to help resource local communities and government efforts to center equity.

Participatory budgeting, which allows community members to decide how to spend portions of the public budget should be considered to align with the city's stated values of equity and

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Network. https://www.usdn.org/uploads/cms/documents/community_engagement_to_ownership_-_tools_and_case_studies_final.pdf

[59] Liao, L., Warner, M. E., & Homsy, G. C. (2020). When do plans matter? *Journal of the American Planning Association, 86*(1), 60-74. doi:10.1080/01944363.2019.1667262

[60] Center on Philanthropy & Public Policy. (n.d.). *Los Angeles Urban Funders: Philanthropic Initiatives in the Aftermath of the 1992 Civil Unrest: Center on Philanthropy & Public Policy*. Center on Philanthropy Public Policy. https://cppp.usc.edu/research/los-angeles-urban-funders/.

[61] Strategic Framework. Council of Michigan Foundations. (2020, October 28). https://www.michiganfoundations.org/node/205155/.

[62] Truth, Racial Healing & Transformation. Council of Michigan Foundations. (2020, March 31). https://www.michiganfoundations.org/trht.

[63] Ibid.

[64] Ibid.

[65] Ibid.

inclusion.[66] Greensboro North Carolina is a similarly sized city to Richmond that has introduced a form of participatory budgeting (PB) into their planning process. Residents from each city council district are allocated a budget of $100,000 for community projects[67]. Each PB cycle lasts two years. During this time residents submit ideas, PB volunteers vet ideas and turn them into project proposals. Residents then vote on which projects to fund. This process is organized by the City's Department of Budget and Evaluation with various other city departments working to implement voter approved projects[68]. The program is funded by taxpayer dollars and through grants from five foundations including the Community Foundation for Greater Greensboro and the Fund for Democratic Communities. Winning projects include $18,000 from each district for a downtown weekend trolly pilot program[69]. Other projects were specific to parks, recreation, environmental issues, and community priorities specific to each city council district[70]. Through a similar approach the OOS will reveal more effective ways to financially support those involved in the planning process.

Budget mapping creates an easy-to-understand graphic that transfers knowledge to the community and allows transparency in government spending. Portland, Oregon has a detailed equity focused budget mapping tool that divides the city into seven neighborhood coalitions and the central city[71]. These maps include a user guide, level of service maps, proposed, and adopted budget maps that all help to explain how revenue and expenditure are spread out through the city[72]. The service level maps are used to rate access to opportunities, rate crime, livability, percentage of parks, access to transportation and other services that can improve quality of life. Portland also tracks the flow of money and investment to different areas of the city and compares these flows over time[73]. Additionally, the city calculates how much money is spent per person in each district. For example, East Portland had the highest spending per person at $161.93 and North West Portland had the lowest at $77.09 per person[74]. Maps compare density, infrastructure conditions, and job availability in each area. All this information works to identify and explain equity issues in the city. Budget mapping could be a useful tool for the OOS moving into the next phases of the RVAGreen 2050 to further prepare to center equity through more transparency and knowledge of municipal resourcing from tax revenue or lack thereof.

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[66] Urban Sustainability Directors Network (USDN). (2019). *From community engagement to ownership: Tools for the field with case studies of four municipal community-driven environmental and racial equity committees.* Urban Sustainability Directors Network. https://www.usdn.org/uploads/cms/documents/community_engagement_to_ownership_-_tools_and_case_studies_final.pdf

[67] Greensboro, NC. Participatory Budgeting | Greensboro, NC. (n.d.). https://www.greensboro-nc.gov/departments/budget-evaluation/participatory-budgeting.

[68] Ibid.

[69] Ibid.

[70] Ibid.

[71] *Budget Mapping*. Budget Mapping RSS. (n.d.). https://www.portlandoregon.gov/cbo/54416.

[72] Ibid.

[73] Ibid.

[74] Ibid.

Summary Table (Opportunities)

What opportunities exist for RVAgreen 2050 to improve on centering equity?			
	Office of Sustainability	Consultative Facilitators	Roundtable Members
Government and Community Readiness	• Continue education/training to help local governments and community members feel better prepared to center equity. • Reassess capacity to further engage with a diverse group of community members that are representative of Richmond's most vulnerable residents. • Ensure that technical terms are not dominating socially oriented terms.	• Ensure there is not a singular domination voice throughout meetings and that all members feel safe, included, and empowered to speak on their experiences and expertise. • Provide the most up to date equity training.	• While RT members may not have formal training or technical experience, they should be reminded of their expertise vital to this planning process. • RT members with technical expertise should listen to laypeople's concerns with their topic and work collaboratively towards addressing concerns.
Community Partners	• Retain frontline community partners and connect them to other city processes, • Incorporate youth engagement strategies especially in frontline communities	• Utilize equity facilitators and consultants regularly to assess and continue to improve planning strategies • Provide guidance to City Staff and RT members for continuing to strengthen/build relationships even after the planning process.	• Expand RT to include neighborhood rather than district so that work is distributed and there are more direct lines to frontline communities' voices • Incentivize RT members to continue working with the city on plans and in other capacities to elevate and embed communities' voices throughout all municipal processes
Shared Definitions	• Work with facilitator/trainers and RT to create an equitable planning checklist for each phase of the process. • Use the checklist as a prompt to start discussions with participants regarding how they view and assess progress individually.	• Ensure that participants' learning about equity and sustainability translate into best practices for the process.	• If the quality of discussions in RT or Working Group settings has at any point deteriorated, reflect on why that might be and try to identify potential areas of compromise. • Consider ways to advocate for participants who may have ideas but not feel comfortable sharing.

Budget	• Practice participatory budgeting • Supplement budget by continuing to research and apply for grants as well as connect and establish long-term philanthropic partnerships to resource community organizations • Implement an equity-based budget mapping tool for public use	• Budget allocation for consultant on larger plans so that city staff is not over extended during certain planning stages	• Provide RT members with their own budget for community engagement • "Build capacity of residents to advocate for voice in municipal budgetary"

B. Capacity Building and Resourcing

Capacity building describes the way individuals, groups, communities, and organizations bolster their skills, processes, situation responses, and resources. The goal of this is to increase the odds of organizational survival, as well as to encourage growth and well-being.[75] Resourcing is the process of sourcing and allocating what a project requires. This can be funding, raw materials, people, or other supportive assets.[76]

Overview of Assessment Indicators

Using the USDN's evaluative model given in its 2018 Community Engagement to Ownership guide as a basis,[77] and adopting the Centering Equity in CAP: Best Practices and Examples equity rating areas[78] as criteria, this section identifies both working strengths and areas of opportunity for RVAgreen 2050 in the following indicator assessment areas:

Assessment Indicator	Definition
Establishing the Team	Development and implementation of recruiting strategy for RVAgreen 2050 Roundtable, working group, and volunteer Ambassador teams.
Co-Learning	Collaborative, listening-driven knowledge-building, and pre-planning processes in which RVAgreen 2050 participates.
Training	Building technical, subject-area, communicative, and collaborative capacity among RVAgreen 2050 paid staff, volunteers, and community partners.
Compensation	Forms of compensation that RVAgreen 2050 offers participants for their time and labor.

Building on What's Working

Establishing the Team: RVAgreen 2050's process for selecting the Roundtable (RT) members looked to successful case studies in other cities[79] and for precedents to inform the process of establishing the team.[80] To invite community members to have a say in the design of its climate resilience plan, RVAgreen 2050 aimed to have at least one member from each of Richmond's

[75] Capacity Building. ramsthaler@un.org. (2014, April 1). Capacity-building [Text]. Retrieved March 22, 2021 from https://academicimpact.un.org/content/capacity-building

[76] RESOURCING (noun) American English definition and synonyms | Macmillan Dictionary. (n.d.). Retrieved March 22, 2021, from https://www.macmillandictionary.com/us/dictionary/american/resourcing

[77] USDN. (n.d.). USDN From Community Engagement to Ownership: Tools for the Field with Case Studies of Four Municipal Community-Driven Environmental & Racial Equity Committees. Urban Sustainability Directors Network.

[78] Fisher, B. (2021). Centering Equity in CAP - Best Practices and Examples. RVAgreen 2050.

[79] Toronto Environmental Alliance, D. (2020). An Equity-Focused Review of the City of Vancouver's Draft Climate Emergency Action Plan: August 2020 (p. 22). Toronto Environmental Alliance.

[80] Fisher, B. (2021). Centering Equity in CAP - Best Practices and Examples. RVAgreen 2050.

nine city council districts represented on the RT. In the cases of the city's most marginalized communities, they staffed the RT with two representatives from each of these districts.[81]

Though the applicant pool of RT residents was small, those who applied were highly engaged and interested in the equity aspect of community development. Many of these residents already had strong backgrounds in community organizing and local environmental issues reaching back decades.[82] This strong core of equity and social justice awareness served to anchor the more technically-minded working groups in a mission agenda that was continually mindful to include and to elevate underrepresented voices. Critically, the RT was tasked with synthesizing the working groups' recommendations into a singular, actionable plan.

Co-Learning: RT members worked with city staff and facilitators to create a space of intentional, mutual learning. Despite being unable to meet in person due to COVID constraints, a core group of RT residents has consistently shown up to online meetings. Members' regular attendance served as the foundation for a learning dialogue that reinforces attendees' understanding of equity in terms of its concepts, applications, and importance.

The RT's present transition to outreach and community engagement will present salient opportunities for collaborative partnerships with impacted community groups and through these additional co-learning opportunities. RVAgreen 2050's targeted universalism approach will be a critical framework to present program objectives in a way that educates and builds consensus among Richmond's diverse populations and communities. The diversity of the RT's residents stands to support these outreach efforts strongly.

Among city staff, there was a developed theoretical understanding of ecological mechanisms threatening community resilience and a keen sense of the need to relate relevant climate science to current community equity goals. A major part of this will be the incorporation of a climate equity index in metrics and analysis of the next phase.[83] As RT outreach efforts increasingly involve voices of community members most in need of being heard, the project will better be able to define actionable goals for its equity research and capacity building, as these goals will reflect actual needs in the community.[84]

Training: To further equip project staff with the awareness needed to center equity in their dealings with local communities, city staff instituted equity trainings for all RVAgreen 2050 staff.[85] Residents and city facilitators[86] used a common language when referring to the purpose and objectives of the RT: to listen to and promote the voices of marginalized community

[81] Fisher, B. & Norell, K. (2021, February 15). Personal Interview. [Zoom Call].

[82] Anonymous (P1), Anonymous (P2), & Anonymous (P3). (2021, March). Personal Interview. [Zoom Call].

[83] Fisher, B. & Norell, K. (2021, February 15). Personal Interview.

[84] Anonymous (P1), Anonymous (P2), & Anonymous (P3). (2021, March). Personal Interview. [Zoom Call].

[85] Fisher, B. & Norell, K. (2021, February 15). Personal Interview. [Zoom Call].

[86] Walden, E. & Freeman, M. (2021, February 22). Personal interview. [Zoom Call].

members.[87] This unified ethos reflected both the efficacy of the training and the team culture's cohesiveness that emerged from this educational process. As the RT moves forward in actively engaging community members, this commonly-held sense of a mission will serve as a strong basis for specific actions to elevate stakeholders' voices.

Ultimately, project outcomes may include building equity in impacted communities themselves, through educational outreach and possible expansion of access to critical resources that will help these communities stay informed as to climate threats and adaptive responses. In the meantime, city staff have voiced the hope that RVAgreen 2050's current efforts will undo some of the harm that institutions have inflicted on these communities through systemically racist and inequitable policies and practices.[88]

Compensation: RT residents were paid for their work, and soft benefits additionally included skill development and professionalization opportunities ensuing from their involvement. RVAgreen 2050 enlisted the services of a City of Richmond grant writer to acquire funds for various project initiatives.[89] This included obtaining funding, for instance, to bring in Virginia Community Voice to provide equity training during the initial project phase.

While RT residents' contracts specified a one-year term of employment, at least one of them expressed a sense that their work would continue beyond the end of this contract period through volunteer and/or advisory service.[90] Residents seemed to perceive the immediate value of their work, and this was reflected in their stated interest in future community development and engagement in such a capacity that would build on and extend their present accomplishments.

What is working well with respect to RVAGreen 2050's Capacity Building and Resourcing?			
	Office of Sustainability	Consultative Facilitators	Roundtable Members
Establishing the Team	• Case-study approach identified strong precedents in other cities • Well-conceived representational structure, with balanced recruitment of Roundtable residents from each of the nine city council districts, promoted diversity of team culture	• Consultants' experiential and theoretical knowledge established appropriate personnel training goals and realistic equity research capacity building timeline	• Strong sense of civic engagement and community organizing experience among residents resulted in a high-energy, high-engagement team • Diversity of Roundtable served to center equity and maintain working group alignment with overarching

[87] Anonymous (P1), Anonymous (P2), & Anonymous (P3). (2021, March). Personal Interview. [Zoom Call].

[88] Fisher, B. & Norell, K. (2021, February 15). Personal Interview.

[89] Fisher, B. & Norell, K. (2021, March 30). Personal Interview.

[90] Anonymous (P1), Anonymous (P2), & Anonymous (P3). (2021, March). Personal Interview. [Zoom Call].

			project ethos and mission agenda
Co-Learning	• Prior background in ecological sustainability research and practice bolstered efforts toward centering equity in the project's climate resilience plan • Climate equity index incorporation in next-phase analytics will strengthen the bridge between ecological and equity frameworks	• Cross-contextual fluency in equity-centered approaches, such as targeted universalism, guided and shaped the educational process of Roundtable residents and ensures a unified sense of purpose, namely to elevate marginalized community voices	• Strong attendance among majority of residents established robust co-learning dialogue • Diversity of Roundtable residents established an optimal foundation for forthcoming outreach and community co-learning opportunities
Training	• Instituted equity training for all staff • Scope of efforts included undoing of harm caused by institutions' systemically racist and inequitable policies and practices	• Defined terms and informed discourse that empowered Roundtable residents to take a proactive role in determining project direction	• Equity training and cohesive team culture resulted in shared ethical language and vision • Unified sense of purpose created a generative context for targeted community engagement during forthcoming outreach phase
Compensation	• Successfully obtained funding for various project initiatives through City of Richmond-supplied grant writing service	• Provided with professional development opportunities through project involvement at all participation levels	• Compensated for time and effort during one-year contract period • Expressed interest in possibility of continuing/extending work beyond term of residency

Opportunities for Next Steps

Establishing the Team: At all levels there is a clear program to achieve partnership and coalition building. Despite the COVID-19 pandemic, the RVAgreen 2050 core staff is well established. However, there needs to be more corporate involvement at this level, bringing experience and ownership to the plan's future business partners.[91] Further, their corporate sponsorship in the process will increase training and funding opportunities.[92] Each interviewee was explicit in saying that recently (February into March) there has been a definite transition into designing an outreach program. The background on that program and its purpose are necessary for further community outreach, inclusion, and training programs in the city.[93]

[91] Urban Sustainability Directors Network (USDN). (2019). *From community engagement to ownership: Tools for the field with case studies of four municipal community-driven environmental and racial equity committees.* Urban Sustainability Directors Network, p.49.

[92] Fisher, B. & Norell, K. (2021, February 15). Personal Interview.

[93] Anonymous (P1), Anonymous (P2), & Anonymous (P3). (2021, March). Personal Interview. [Zoom Call].

Co-Learning: The current program has highlighted that the outreach was a successful effort. However, certain groups are not represented and their voices need to be included; the literature notes that the absence of these perspectives can undermine the credibility of a climate action plan.[94] As an example, the High School Representative on the RT cannot attend the regularly scheduled meetings due to school - erecting more barriers than they already face is counter to an inclusive program. RT community members have now been trained in outreach for the next stage in the planning process, and this is the logical and equitable next step. In parallel to those actions a strong community capacity building program will need to be inserted into disadvantaged communities through already established channels, with the ultimate goal of empowering impacted groups with ownership and oversight of these planning processes.[95]

Training: Recognizing the impacts of the pandemic, the expected depth of the training in Equity and Sustainability has been limited.[96] However, as the Ambassador program kicks off, the need to develop community skills, abilities, and common language as it relates to equity and sustainability principles remains the priority. Currently, the two RT facilitators switch hats between their facilitator and trainer roles - these momentary switches can lead to confusion.[97] By dividing these roles, the facilitators can better focus on 'hearing' the needs of the community members.

Compensation: As mentioned in previous sections, the need to continue outreach is paramount for the RVAgreen 2050 process to achieve success. City staff see community impacts being disproportionate for communities that have limited to no voice in government processes. Further commitment financially to the outreach to and training of these frontline neighborhoods is needed. Currently there is limited penetration of the skill-building related to equity and sustainability training in disadvantaged neighborhoods and populations. Funding these training seminars and outreach events is the next step to ensure that the RVAgreen 2050 document reflects clear understanding of those populations.

What opportunities exist for RVAgreen 2050 to better foster capacity building and resourcing?			
	Office of Sustainability	Consultative Facilitators	Roundtable Members
Establishing the Team	• Involve more corporate partnerships for higher	• More community members are needed to be funnelled	• Continue to design and build outreach program

[94] Collaborating for Equity and Justice: Moving Beyond Collective Impact. (2017, January 9). Non Profit News | Nonprofit Quarterly. https://nonprofitquarterly.org/collaborating-equity-justice-moving-beyond-collective-impact/

[95] Arnstein, S. R. (1969). A Ladder Of Citizen Participation. Journal of the American Institute of Planners, 35(4), 216–224. https://doi.org/10.1080/01944366908977225

[96] Urban Sustainability Directors Network (USDN). (2019). *From community engagement to ownership: Tools for the field with case studies of four municipal community-driven environmental and racial equity committees.* Urban Sustainability Directors Network, p.16-17.

[97] Walden, E. & Freeman, M. (2021, February 22). Personal interview.

	levels of funding for RVAgreen 2050 events [98] ● Utilize outside funding sources for increased community outreach	through the Roundtable training ● Local seminars, training events, and related outreach are needed to ensure true equity is reached for RVAgreen 2050 [99]	within the Roundtable begun recently ● Utilize Roundtable members to resource local knowledge from each district to build further WG that better reflect Richmond's diversity[100][101]
Co-Learning	● City planning processes did not fully integrate needed community voices in the design, with logistical hurdles impeding access to some groups [102]	● Successful community engagement phase will depend on facilitators providing clear cues as to what success looks like ● Hiring dedicated facilitators for each working group keeps discussions with on the main equity objective	● Roundtable outreach phase needs to identify partners and allies in impacted communities in order to promote building greater capacity for these groups themselves [103]
Training	● Equity and Sustainability trainings had limited reach due to COVID constraints; use Ambassador and Roundtable outreach efforts to build staff and volunteer capacity in these areas[104]	● Dual role of facilitators also acting as trainers may send mixed messages; division of functions may provide clarity for trainees[105]	● Preliminary community outreach efforts were beset with obstacles to communication. A grassroots approach would better enable residents to level with peers in these communities.[106]
Compensation	● Community impacts are most severe for communities that have the least role voice in government processes; recompensing these	● Facilitators can mediate the service roles of Roundtable residents and Ambassador volunteers, ensuring their interests are served through monetary compensation and other benefits, such as skill development and	● Equity and sustainability skill-building has yet to result in measurable community benefits.[110] ● Resident outreach efforts will require ongoing funding and clearly demonstrate value to

[98] Fisher, B. & Norell, K. (2021, February 15). Personal Interview.

[99] Walden, E. & Freeman, M. (2021, February 22). Personal interview.

[100] Anonymous (P1), Anonymous (P2), & Anonymous (P3). (2021, March). Personal Interview. [Zoom Call].

[101] Local Assets + Context.pdf: URSP-637-C91-SP2021—SUSTAINABLE COMMUNITY DVLPMT. (n.d.). Retrieved March 22, 2021, from https://virginiacommonwealth.instructure.com/courses/28121/files/2665115?module_item_id=1039341

[102] Collaborating for Equity and Justice: Moving Beyond Collective Impact. (2017, January 9). Non Profit News | Nonprofit Quarterly. https://nonprofitquarterly.org/collaborating-equity-justice-moving-beyond-collective-impact/

[103] USDN. (2017). USDN Guide to Equitable, Community-Driven Climate Preparedness Planning. Urban Sustainability Directors Network. Pg 28.

[104] Fisher, B. & Norell, K. (2021, February 15). Personal Interview.

[105] USDN. (2017). USDN Guide to Equitable, Community-Driven Climate Preparedness Planning. Urban Sustainability Directors Network. Pg. 33. "Employ a Train-the-Trainer model…"

[106] USDN. (n.d.). USDN From Community Engagement to Ownership: Tools for the Field with Case Studies of Four Municipal Community-Driven Environmental & Racial Equity Committees. Urban Sustainability Directors Network. Pg. 61.

[110] Anonymous (P3). (2021, March 15). Personal Interview. [Zoom Call].

	marginalized groups is a priority among city staff [107]	professionalization opportunities [108][109]	community participants, justify the time and effort spent[111]

C. Frame Mission

Governments have a history of originating and exacerbating inequities and often exclude the public from fully participating in planning processes that can address such inequities.[112] As such, appropriately framing the mission of these processes is as imperative to the success of equitable climate action planning as to the healing of broken relationships with the community. A clearly defined mission provides the groundwork for the rest of the process. Thus, it is important to ensure stakeholders have a clear understanding of the overall mission and where they fit within the process.[113]

Overview of Assessment Indicators

Appropriately framing the mission of a planning process is critical, and it is particularly so with the RVAgreen 2050 process given the equity focus, which has largely been absent from the overall sustainability planning field until recently.[114] With this commitment to equity, community involvement is necessary. Specifically, communities that have suffered under racist policies need to be included in the planning process, as they will experience an increased risk to climate change.[115] Participation by these impacted communities needs to consist of more than just the government informing them of its plans; instead, there needs to be collaborative governance, which "is the co-definition of problems and the co-development of solutions among multiple sectors."[116] Moreover, as part of the development of solutions, there needs to be emphasis on co-benefits in order to have a meaningful impact on reducing disparities.[117] Given such a framework is needed in order to narrow the equity gap, this section includes an

[107] Ibid, Pg. 57. "Train and pay young adults to serve as outreach workers."

[108] Ibid, Pg. 30. "Host and conduct a community leadership training program."

[109] Walden, E. & Freeman, M. (2021, February 22). Personal interview.

[111] Engaging Community_URSP 637.pdf: URSP-637-C91-SP2021—SUSTAINABLE COMMUNITY DVLPMT. (n.d.). Retrieved March 22, 2021, from https://virginiacommonwealth.instructure.com/courses/28121/files/2665128?module_item_id=1039344

[112] Urban Sustainability Directors Network (USDN). (2017). *Guide to equitable, community-driven climate preparedness planning*. Urban Sustainability Directors Network. https://www.usdn.org/products-climate.html#GuideClimate

[113] Urban Sustainability Directors Network (USDN). (2019). *From community engagement to ownership: Tools for the field with case studies of four municipal community-driven environmental and racial equity committees.* Urban Sustainability Directors Network. https://www.usdn.org/uploads/cms/documents/community_engagement_to_ownership_-_tools_and_case_studies_final.pdf

[114] Loh, C. G., & Kim, R. (2020). Are we planning for equity? *Journal of the American Planning Association*, *0*(0), 1–16. https://doi.org/10.1080/01944363.2020.1829498

[115] USDN, 2017. Op. cit.

[116] USDN, 2019. p. 7. Op. cit.

[117] USDN, 2017. Op. cit.

assessment on how well the OOS has done with respect to the following areas - equity commitment, co-develop with the community, prioritize co-benefits, and reduction of disparities.

Assessment Indicator	Definition
Equity Commitment	A commitment to incorporating a racial equity lens throughout the entire planning process.[118] Specifically, the OOS has committed to transparency and inclusivity with the ultimate goal of starting to make an impact with respect to reducing disparities.[119]
Co-develop with community	Co-developing with the community centers the voices and needs of the community in this project; a collaboration, instead of taking just a "consulting" or "informing" position. The *Virginia Community Voice Blueprint*[120] points out that community engagement activities that inform, consult or involve usually fall short of promoting ownership because they don't give community members authority to make meaningful decisions. The advocacy of the community from a collaborative stance allows for the building of climate justice policies that are rooted in the community's priorities.[121]
Prioritize co-benefits	Co-benefits are the beneficial outcomes that a community receives from taking climate actions that are not directly related to climate mitigation. For example, weatherizing homes and providing incentives for solar can reduce costs for renters and homeowners. Actions, such as increasing the amount of green space and active transportation infrastructure, can improve public health, increase safety, support economic stability, and increase biodiversity.[122]
Reduction of disparities	Focused on minimizing the issues explicitly mentioned by those in the planning process. These tend to be artifacts from past planning initiatives, this tends to hinge on redlining and other discriminatory practices. While these are referred to as artifacts the impacts of this are felt by communities to this day, these tend to include factors such as heat island effect, health disparities, and access to resources.

Building on What's Working

Equity Commitment

The OOS has made a public commitment to centering equity in the RVAgreen 2050 process:

"Due to historic and institutional racism, people of color are more likely to live in more marginal and exposed areas that are more susceptible to climate impacts. For these reasons, it is critical

[118] Fisher, B. & Norrell, K. (2021, February 15). Personal interview.

[119] City of Richmond. (n.d.). *What is RVAgreen 2050?* RVAgreen 2050. https://www.rvagreen2050.com/what-is-rvagreen-2050.

[120] Virginia Community Voice Blueprint. (n.d.) Virginia Community Voice.

[121] USDN, 2017. Op. cit.

[122] Urban Sustainability Directors Network (USDN). (2017). *Guide to equitable, community-driven climate preparedness planning*. Urban Sustainability Directors Network. https://www.usdn.org/products-climate.html#GuideClimate

that the City of Richmond's efforts to address climate change are carried out in a way that is inclusive of and protects our most vulnerable communities."
RVAgreen 2050 website - Overview page

Given the heightened focus on equity from different angles, such as transparency and inclusivity, three positive aspects of the overall process are the inclusion of the Roundtable (RT) in the planning process and other city departments on the Working Groups,[123] along with the government's broader equity focus under the Stoney administration.[124] These aspects of the process are particularly important, as research provides evidence that this type of approach - i.e., community participation and explicit equity goals - has led to greater equity outcomes. Moreover, collaboration with other city departments has shown to keep the momentum around implementation going past the initial development of the plan.[125] In addition, the inclusion of the RT is in alignment with what other American cities have done[126] and also aligns with the OOS' transparency and inclusivity goals.

Co-develop with Community

From the beginning of this process, co-developing with the community has been a priority for the city staff, the facilitators, and the RT members. City staff emphasized removing the "one size fits all" mentality with community communication and engagement, and one staff member said that "it needs to be what resonates with them, not just what resonates with me."[127] This approach can be seen through the website, which provides multiple opportunities to get connected, involved, and participate with RVAgreen 2050. Providing the necessary expertise on race relations and equity, while continually training through an equitable lens was no easy feat for the facilitators of this program. One facilitator described their role as "answering the so what, who cares" when it comes to conceptualizing where equity and the climate meet.[128] RT members also valued their role in this process -- one interviewee felt that it was "important to me to be part of the solution" and another wanted to "elevate those voices when we get to the decision making.[129]"

Another RT member gave insight to some of the concerns about how to collaborate with the community on issues such as climate change and equity, especially when it comes to the terminology about environmental issues. Their response to this concern in the interview is as follows: "And someone may say, well, why did they pick this? Why did you use this language? And I say, well, this is what we've been using. Likewise, I can also go back to the round group

[123] Fisher, B. & Norrell, K. (2021, March 30). Personal interview.

[124] City of Richmond. (n.d.). *Richmond's equity agenda | Richmond*. https://www.rva.gov/rvaequity

[125] Liao, L., Warner, M. E., & Homsy, G. C. (2020). When do plans matter? *Journal of the American Planning Association*, *86*(1), 60–74. https://doi.org/10.1080/01944363.2019.1667262

[126] USDN, 2019. Op. cit.

[127] Fisher, B. & Norrell, K. (2021, February 15). Personal interview.

[128] Walden, E. & Freeman, M. (2021, February 22). Personal Interview.

[129] Anonymous (P1) & Anonymous (P2). (2021, March). Personal Interview. [Zoom Call].

and say, Hey, so we use this word, we use the word (You know, we may say racial equality). And the working group may say no, let's not use that word, it is still not encompassing of everyone. Let's use this word. And so then I'll go back and I'll say so listen, we talked about this in groups - What do you think about this? They thought it was too harsh. They looked at the wording, maybe it was too thesis-like. Let's break it down. We gotta keep it simple for everyone so that we don't have to have interpreters for the vision that we're trying to carry out."[130]

Prioritize Co-benefits

For RVAgreen 2050, the City has taken steps similar to other cities that have used co-benefits as a driving strategy by collaborating with other agencies and organizations.[131] Collaboration with multiple stakeholders can help to increase the understanding of what the community priorities are and can help to address multiple challenges at the same time. The City has also developed the goals and strategies for RVAgreen 2050 holistically, by ensuring that climate action is incorporated across multiple sectors, such as transportation infrastructure and housing, which case studies have shown to be a highly successful method to address multiple issues at once.[102]

This process has been improved upon with the facilitators using a targeted universalism strategy, which ensures that frontline communities and those most heavily impacted by climate change receive the most benefit from taking climate action. The facilitators' educational role helped to establish why frontline communities should receive priority for receiving the co-benefits of taking climate action. The education provided by the facilitators helped RT members and working groups have a better understanding on their roles and how to prioritize potential strategies.[132] RT members work collaboratively with the WG's and both parties help to inform and educate the other on existing problems and create goals and strategies based on what the community priorities are.[133] This process helps to ensure that co-benefits are built into the planning process for RVAgreen 2050.

Reduction of Disparities

The RVAgreen 2050 planning process has communicated clearly that climate change affects some members of our community more than others. One notable strategy is the creation of the Climate Equity Index, which identifies the communities in Richmond that are on the frontlines of the climate change crisis. Using this Index as a reference, the RVAgreen team has reached out to these frontline communities to engage in the planning process. The Climate Equity Index allows people to visually understand the culmination of factors that impact communities in the Richmond area, including socioeconomic factors such as health, education, and poverty, and climate factors such as tree canopy coverage or areas with high amounts of impervious surface.

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[130] Anonymous (P4). (2021, March). Personal Interview. [Zoom Call].

[131] The Co-benefits of Climate Action: Accelerating City-level Ambition. (2020). Tyndall Center. https://www.preventionweb.net/publications/view/73173

[132] Walden, E. & Freeman, M. (2021, February 22). Personal Interview

[133] Anonymous (P3). (2021, March 15). Personal interview

Together, these allow us to identify areas where there may be a disproportionate impact of climate change.

One of the most impactful actions to prioritize the reduction of disparities is the empowerment of the RT members. This has led to learning and a deeper understanding of climate change and the impacts on frontline communities. For example, one RT indicated that they now understand why there are differences in air quality between neighborhoods, specifically when comparing Jackson Ward to other parts of Richmond.[134] By empowering citizens and building positive relationships we are making strides towards community ownership.[135]

What is working well with respect to RVAgreen 2050's overall mission?			
	Office of Sustainability	Consultative Facilitators	Roundtable Members
Equity Commitment	• Included the "racial equity & environmental justice" community priority • Established the Racial Equity & Environmental Justice Roundtable (RT) • Required the use of an equity evaluation tool • Engaged local equity experts to serve as facilitators • Engaged VCU for a mid-point equity assessment • Broadened the equity focus in the government by including other city departments in the process, which ties in with Mayor Stoney's broader Equity Agenda	• Provided racial equity expertise to the OOS in relation to the design of the process • Involved with supporting the RT by facilitating meetings and providing training	• Committed to bringing the equity and resident lens to the overall process • Committed to engaging with frontline communities and elevating their voices
Co-develop with community	• Provided multiple opportunities to promote and enhance community collaboration on their website • Removed the "one size fits all" mentality with community communication and engagement	• Trained for community engagement through an equitable lens -- Matthew Freeman: "*Adaptive leadership, adaptive change*"	• Prepared for community engagement while ensuring that there could be collaboration, not just informing or consulting
Prioritize co-benefits	• Collaborated with agencies to help strategize co-benefits, such as the Partnership with the Office of Community Wealth Building to strategize job growth and training programs, and working with citizens for neighborhood	• Used targeted universalism as a strategy method, ensuring communities facing the most impact from climate change, receive the most benefit from taking action • Helped to frame why benefits should be prioritized to specific	• Served as a liaison for the community to understand specific needs and assets • RT members and WG members educated each other on disparities and addressed potential strategies to provide benefits

[134] Anonymous (P4). (2021, March 22). Personal interview.

[135] USDN, 2019. p. 26. Op. cit.

	improvements • Incorporated climate action strategies across a wide variety of City sectors • Created strategies based on community priorities	communities in Richmond	• Community WG reviewed strategies proposed by other working groups and ensured that the strategies reflect community priorities
Reduction of disparities	• Emphasis on a transparent process especially through use of their website and RT members. • The creation of the climate equity index allows users to visualize the overlap of climate issues and aspects that could make people vulnerable.	• Commitment to equity training and education helps to provide an even jumping off point.	• Advocated for their needs and wishes in the community to trainers and each other. • Pointed out flaws in the ways of thinking, specifically the distinction between zip code and neighborhood other disparities have also been pointed out. • Many people in this group signed up to help identify and disparities in their communities.

Opportunities for Next Steps

Equity Commitment

RVAgreen 2050's equity focus is on centering and elevating the voices of frontline communities. One way the OOS has sought to achieve this goal was by including a community group, specifically the RT, within the process. In our analysis of the RT application, the OOS sought residents from frontline communities, which for Richmond would generally consist of lower-income communities of color, which aligns with the focus on racial equity. However, the composition of the RT does not appear to be in full alignment with this definition, as the RT is roughly 50% White/Caucasian.[136] In regards to the income levels, it is difficult to determine, as low-income is not defined in the RT application, and in looking at the Richmond Redevelopment & Housing Authority as a proxy, the number of individuals in the household plays a role, and that data point was not collected.[137] Given the voices of frontline communities are central to this process and trust plays the largest role when reaching out to the community,[138] the OOS may want to consider re-engaging with certain community-based organizations in order to supplement RT outreach. Community-based organizations already have established relationships, which may help in getting quality feedback.

With the RT being a key stakeholder in this process, it is imperative that community members have a clear understanding of their role. A consistent theme that we heard from RT interviews

[136] City of Richmond - Office of Sustainability. (n.d.). *Roundtable and working groups demographics report.* *https://www.rva.gov/sites/default/files/2020-12/RVAgreen%202050%20Roundtable%20and%20Working%20Groups%20Demographics%20Report%2012.7.2020.pdf*

[137] Richmond Redevelopment & Housing Authority. (n.d.). *Public housing program.* *https://www.rrha.com/housing/public-housing/*

[138] Virginia Community Voice. (n.d.). *Virginia community voice blueprint*. https://vacommunityvoice.org/blueprint.

was that responsibilities weren't necessarily fully understood. RT members have an understanding of their role with respect to engaging the community and elevating frontline community voices; however, in certain situations, such as their role in the Working Groups, there has been a lack of clarity, especially in the beginning of the process. This theme is highlighted with the following RT member quote:

"I've seen us kind of wrap our heads around it as a team. We are, you know, just members of the community. We don't have any experience working in any sort of planning like this. So, we all have different backgrounds and everything….the way it has evolved is we've just gotten a better understanding of what our role is. And as things progressed, it's kind of like you don't really get it until you jump in and really do it and see where your impact is."

The USDN outlines that a charter can be helpful, as it can outline aspects such as "roles of partners, expectations, decisions to be made, levels of review and feedback required, and effective communication and outreach strategies."[139] As a result, the OOS may want to consider creating a charter for the remaining phases of the planning process. Washington DC's *Technical Appendix* provides an example,[140] which can serve as a starting point. For the RVAgreen 2050 charter, we suggest that the OOS consider including not only the responsibilities of the RT but also how to operationalize those responsibilities in practice, as that seems to be where the gap exists. It seems like Providence ran into a similar challenge with roles, and its community group, the Racial & Environmental Justice Committee (REJC), ended up creating "role descriptions and expectations for themselves and city staff."[141] With respect to RVAgreen 2050, we suggest the OOS co-create the charter with the RT and facilitators.

Turning from the RT, we also want to highlight the importance of a "whole-government approach" by which silos are broken down among departments, and there is cross-collaboration to address the root of the issues. Such an approach is important because both climate change and structural racism present complex challenges that require multiple stakeholders to be involved in the solutions.[142] Community members from other cities that instituted a similar process to RVAgreen 2050 recognized and voiced the need for this broader approach. One example is from Seattle, Washington, in which feedback was provided that trust had grown between the city officials and community members involved in the specific sustainability planning efforts; however, that growth in trust did not necessarily translate to other government departments, as it was not clear where those departments stood with respect to equity and partnering with the community.[143] Given the importance of this "whole-

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[139] USDN, 2017. p. 31. Op. cit.

[140] Washington D.C. (2018). *A guide to community-centered engagement in the District of Columbia: Technical appendix.* https://www.georgetownclimate.org/files/report/CEG-TechnicalAppendix-10-2018-FINAL.pdf

[141] USDN, 2019. p. 56. Op. cit.

[142] USDN, 2017. Op. cit.

[143] USDN, 2019. Op. cit.

government approach," the OOS may want to consider highlighting the number of city departments that are currently involved in the RVAgreen 2050 efforts[144] and outlining the connection that the RVAgreen 2050 process has with Mayor Stoney's broader equity focus,[145] as well as the Richmond 300 strategic plan. By highlighting these current efforts, it will help bring awareness to the public of what steps the city has already taken.

In addition to publicizing the broader city involvement, the OOS may want to consider assessing the equity knowledge gained through the process via a survey. The survey results from city staff can help serve as a baseline for future surveys to measure the city's progress. Moreover, to help further support equity efforts, the OOS may want to consider creating a cross-departmental group that would be responsible for continuing the equity efforts going forward.[146] The Government Alliance on Race & Equity has a resource - *Racial Equity Core Teams: The Engines of Institutional Change* - that may be helpful if the OOS decides to implement a cross-departmental equity team. This resource provides guidance on various aspects, such as examples of the types of responsibilities the team could have.[147] Moreover, the OOS may find it helpful to review information related to Seattle's Race and Social Justice Initiative, which is a "citywide effort to end institutionalized racism and race-based disparities in City government."[148] The website includes information, such as an organizational chart and the results from the periodic surveys that Seattle has conducted,[149] which may help the OOS gather ideas for Richmond. These additional efforts - surveying city staff and creating a cross-departmental equity group - would further demonstrate the OOS', as well as the city's, commitment to equity.

Co-develop with Community

COVID-19

The negative implications of a global pandemic on community engagement do not fall onto the City staff, facilitators, or RT members. COVID-19 has further heightened the issues of accessibility, especially when it comes to online communication and collaboration. When it comes to training the RT members for community engagement and collaboration, it prompts the question -- *Would equitable training be more effective in person?* As the pandemic continues, there is concern about what community members might not be "heard" if they are weary about meeting in-person or in-person events.

Community Representation

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144 Fisher, B. & Norrell, K. (2021, March 30). Personal interview.

145 City of Richmond. (n.d.). *Richmond's equity agenda | Richmond*. https://www.rva.gov/rvaequity

146 USDN, 2019. Op. cit.

147 Government Alliance on Race & Equity. (2018). *Racial equity core teams: The engines of institutional change.* https://www.racialequityalliance.org/wp-content/uploads/2018/11/RaceForward_CORETeamsToolkit-10.2018.pdf

148 City of Seattle. (n.d.). *Racial and social justice initiative.* Retrieved April 30, 2021, from http://www.seattle.gov/rsji/about

149 Ibid. http://www.seattle.gov/rsji/resources

One RVAgreen 2050 facilitator pointed out that the Engagement Phase 1 survey results showed that there is still a lot of work to do in order to reach the goal of making sure that the demographics they are reaching are truly representative of the City of Richmond.[150] If there is not a truly representative voice being "heard" -- then there might not be true "collaboration" on this project. The Virginia Community Voice Blueprint found in their experience that community engagement activities that inform, consult, or involve usually fall short of promoting ownership because they do not give community members authority to make meaningful decisions.

Prioritize Co-benefits

Ensure frontline communities needs are prioritized

Outreach is essential to the equity component of RVAgreen 2050, and co-benefits that reflect the existing needs of communities are dependent on comprehensive community engagement. The City should increase its outreach efforts to ensure RT and WG members are able to strategize effectively, by ensuring that all voices are effectively heard. To accomplish this effectively, it is urgent that outreach is expanded to hard-to-reach communities and attempt to increase diversity in the working groups.

Quantify co-benefits to maximize impact

Case studies have shown that quantifying co-benefits are also an effective way to understand which strategies and co-benefits would have the largest impact.[151] If Richmond begins quantifying the co-benefits it would allow for the City to identify which strategies would have the largest impact, and targeting those specific actions. This should be done in conjunction with the established community priorities, ensuring that these priorities are met comprehensively. For example, benefits such as weatherizing homes to reduce utility bills, or various types of green infrastructure could be quantified to provide a cost and benefit comparison. Therefore, the community could identify and understand which benefit would have the highest impact. C40 Cities, a collaboration between 97 cities to tackle climate change, provides numerous case studies for OSS to review and help guide them in quantifying co-benefits. [152]

Increase education efforts to ensure everyone understands co-benefits

While co-benefits are built into RVAgreen 2050, RT and WG members may still have confusion on what their exact roles are which could limit the impact of the strategies that are being developed. Educational efforts should be increased for everyone involved in the RVAgreen 2050

[150] Walden, E. & Freeman, M. (2021, February 22). Personal Interview.

[151] The Co-benefits of Climate Action: Accelerating City-level Ambition. (2020). Tyndall Center. https://www.preventionweb.net/publications/view/73173

[152] C40 Cities- Benefits Research Programme (2021) https://www.c40.org/benefits

process, to ensure everyone fully understands co-benefits and how they should be prioritized. Benefits can also potentially increase inequities, such as green space resulting in property value increases, so it is important that benefits are planned carefully, and having a stronger co-benefit educational component could help mitigate these risks. [146]

Reduction of Disparities

One way to foster the reduction of disparities through the RVAgreen 2050 process is through education about how and why frontline communities are unevenly impacted by climate change. While the RT is building knowledge in this area, there is room for more education in the WG and in the general public. Providence, Rhode Island has used "anti-oppression training" to empower residents and educate the officials in power.[153] This training acted to increase resident empowerment in Providence, which was critical to the process. Anti-oppression training approach may be a useful tool to use in Richmond to educate persons who have not historically been oppressed to gain an understanding of impacts and of course ways to not add to these issues.[154]

What opportunities exist for RVAgreen 2050 to better meet its mission?			
	Office of Sustainability	Consultative Facilitators	Roundtable Members
Equity Commitment	• Consider re-engaging with community-based organizations to ensure frontline communities are reached • Consider publicizing the interdepartmental collaboration and connecting it with Mayor Stoney's broader equity focus • Consider surveying RVAgreen 2050 participants to gauge equity knowledge • Consider creating a cross-departmental equity group • Consider creating a RT charter that outlines roles and responsibilities for the remaining phases	• Ensure frontline community voices are heard through the community engagement process	• None
Co-develop with community	• Address accessibility concerns, especially when it comes to reaching communities who have experienced online/internet accessibility issues due to COVID-19	• Consider creating more opportunities to include background information (or "homework") for the Roundtable members in order to increase how well the engagement is received	• None
Prioritize co-	• Improve outreach to include more		• RT and WG should have

[153] USDN, 2019. p. 27. Op. cit.

[154] Ibid.

benefits	hard to reach populations, especially in frontline communities, to have a better understanding of what their needs are and what benefits would have the most impact ● Quantify co-benefits of various mitigation strategies to understand which benefits should be prioritized and would have the largest impact ● Ensure frontline communities voices are fully heard in order to prioritize co-benefit strategies	● Increase the amount of education regarding the co-benefits that can come with taking climate action for WG and RT members	more education on what their specific roles are and how they can specifically prioritize co-benefits into the proposed goals and strategies ● RT should bolster outreach to hard to reach populations to allow for a comprehensive understanding of the community priorities
Reduction of disparities	● Provide increased trainings for RT members ● Increased transparencies between the city and the residents	● Empower the Roundtable members more when they are in the working groups, it seems like they may feel undervalued.	● Increased training especially anti-oppression training may be helpful

D. Equitable Decision-Making

An essential element of equitable, community-driven planning for climate resilience and adaptation, specifically, hinges on the transfer of some or all of the decision-making power from traditional planning experts and municipal leaders to nonexperts in the community. While this is vital for any kind of planning process, it is doubly important in climate action planning as vulnerable communities are more often at the frontline of climate change impacts and tend to suffer the consequences of climate change most acutely.[155] For this reason, this kind of inclusive planning process requires that these frontline communities are participants in the decision-making framework. If done effectively, equitable and inclusive climate action planning fosters long-term engagement and centers city stakeholders, residents, and experts around a shared goal.[156] This transfer of power is what facilitates an equitable decision-making paradigm.

To achieve an equitable decision-making framework, a planning process must foster power sharing, transparency, and accountability. These three elements of equitable decision-making frameworks are critical to a meaningful engagement process. Indeed, equitable community engagement, which ultimately leads to shared decision-making opportunities, relies on the principles of shared leadership and community-driven strategy development. Power sharing, transparency, and accountability measures ensure that municipalities are fulfilling their promises of community inclusion. The USDN also advocates for community engagement along these lines. Optimally, the organization states that it involves two-way channels of communication (i.e., accountability), multiple interactions between residents and city staff (i.e., transparency), and shared decision-making towards the advancement of solutions to complex problems (i.e., power sharing). They claim that a successful community-driven and equitable climate action planning process involves "shared decision-making between local government staff and the community with the aim of co-creating an equitable climate preparedness plan...this approach most aligns with shared leadership and community-driven [engagement], where there is an emphasis on a shared decision-making and co-ownership."[157]

[155] Gough, I. (2011). Climate change, double injustice, and social policy: A case study of the United Kingdom (Occasional Paper No. 1). United Nations Research Institute for Social Development. https://www.unrisd.org/publications/op-gough

[156] Loh, C.G. & Kim, R. (2020). Are we planning for equity? Equity goals and recommendations from local comprehensive plans. *Journal of the American Planning Association*, 1-17. DOI: 10.1080/01944363.2020.1829498

[157] Urban Sustainability Directors Network (USDN). (2017). *Guide to Equitable, Community-Driven Climate Preparedness Planning*. Urban Sustainability Directors Network. p. 25. https://www.usdn.org/products-climate.html#GuideClimate

Assessment Indicator	Definition
Power sharing	Power sharing refers to local governments making a commitment to sharing responsibility for decision-making processes and desired outcomes. It is important to ensure that the stakeholders, private, and public entities are active participants and/or leaders throughout any preparation of programs, plans, or policies that might affect them.
Transparency	Transparency means that actions or processes are readily observed and understood, and this is a critical part of an equitable decision-making process. When local governments are transparent about how and when decisions are made, community members can meaningfully participate in and influence these decisions.
Accountability	Accountability measures ensure that all stakeholders are adhering to the principles of equitable, community-driven planning. Local governments must be accountable for meaningfully incorporating community voice and input into the final plan to move beyond performative inclusion and reach shared leadership over the plan and its development.

Thus, to evaluate the degree to which the planning for RVAgreen 2050 has aligned its process with these principles to-date, we identify and track three assessment areas critical to the creation of an equitable decision-making framework: (1) power sharing, (2) transparency, and (3) accountability. Ultimately, it is very important in a process that promotes equitable decision-making to identify participation, transparency, and accountability goals and regularly measure progress toward those goals.[158] In this way, equitable climate action planning tracks progress toward two parallel, but interrelated, objectives of *equitable community participation* and *equitable climate change mitigation and adaptation solutions*. Measures that promote equitable decision-making should be incorporated into both streams. Across the process, city staff should be collaborating with community members "to set equity goals and conduct equity impact assessments before finalizing decisions."[159]

Building on What's Working

Power Sharing

Different approaches to creating planning decisions at a community level are necessary to facilitate equitable outcomes. To ensure an equitable and inclusive planning approach, it requires local governments to share the decision-making process publicly so that all stakeholders understand how and why decisions are made.[160] It is essential to build the capacity of residents to participate in planning efforts to achieve shared power. To do so, residents must be offered the chance to participate in dedicated training to create a shared understanding of the overarching problem, how it affects them, and what participation

[158] USDN, 2019. Op. cit.

[159] Ibid., p. 15.

[160] Ibid.

opportunities are present. City staff must be equally willing to undergo equity training. The City of Richmond Office of Sustainability created the initial pre-planning framework with the help of community partners,[161] showing the initial willingness to collaborate with various stakeholders, and community partners. Richmond staff centered equity as a focal point of the Climate Action Plan with the aid of externally hired consultants to co-create a definition of what equity means to the City of Richmond.[162] Creating a shared definition of equity that is easily understood by stakeholders is a form of power sharing as it builds capacity for stakeholders to actively understand, provide informed feedback, and participate in discussion on policies or plans.[163] To further increase capacity to work on Richmond's racial equity issues, city staff, Roundtable (RT) members, and technical working group members received equity training.

"This approach to planning processes has the potential to build community power and leadership by increasing community capacity to engage in plans and policies that will directly impact them."[164]

Sharing decision-making power necessitates partnerships and collaboration between community residents, or entrusted neighborhood associations, community based organizations (CBOs), local nonprofits, local businesses, and any other community stakeholders that have a pre-existing relationship with residents. Power sharing between the government agencies responsible for planning decisions and community members bridges the gap between the community and governance.[165] When approaching climate change planning from a community-driven framework, decision-making power must be shared with those who will be most affected. To properly plan for a community, the lived experience of residents and entrusted connections between community organizations are invaluable components to properly identifying an area's needs before subsequently making co-defined solutions to address community priorities and concerns.[166] The Office of Sustainability has made a commitment to uplift marginalized frontline communities; centering the voices of frontline communities in this planning process takes the form of virtual ambassador program and the RT. The Office of Sustainability publicly shares all related and relevant information regarding this plan on their website. This keeps Richmond residents and other stakeholders informed and provides opportunities to get involved in the process.

"The Office of Sustainability developed the RVAGreen 2050 Climate Equity Index to identify the communities in Richmond that are on the frontlines of crises such as climate change and are purposefully reaching out to these communities to engage them in our process."[167]

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[161] Fisher, B. & Norrell, K. (2021, February 22). Personal Interview.

[162] RVAGreen 2050. *Understanding Community Priorities*.

[163] USDN, 2019. Op. cit.

[164] USDN, 2017. Op. cit

[165] Ibid.

[166] USDN, 2017. Op. cit.

[167] RVAGreen 2050. *Engagement and Communication*.

The USDN emphasizes the importance of shared power with government agencies and community members when making equitable decisions, regarding plans or policies that affect community members. The USDN power sharing framework acknowledges that to have inclusive and accessible planning decisions that there must be appropriate racial representation on the core planning team. During an interview, a RT member mentioned how important it was to her to have the diversity in positions of authority in the planning process and the need for continuous representation throughout Richmonds Climate Action Plan. [168]

Transparency

Local planning decisions cannot truly be made equitably unless all stakeholders are equipped with the information necessary to make an informed decision, and also understand how and when decisions are made.[169] Therefore, transparency is critical to creating an equitable planning process. In the RVAgreen 2050 planning process, three groups of stakeholders - city staff, consultative facilitators, and the RT - demonstrate a commitment to transparency.

The Office of Sustainability has created and supported transparency in the RVAgreen 2050 process primarily through creating a flexible participatory planning process and engaging in information sharing consistently throughout this process. The office staff indicated that they intentionally created a flexible planning framework that could pivot and change as they received stakeholder input throughout the process.[170] Assessing barriers to equitable decision-making processes and then adjusting a plan accordingly is a critical component of setting the stage for equitable decision making.[171] Using stakeholder feedback to identify barriers to participation and then changing a plan process based on that feedback ensures that more stakeholders can meaningfully participate in the decision making process, and the process is then, overall, more participatory and transparent.

"The Office of Sustainability is committed to centering racial equity in our work, including the RVAgreen 2050 planning process. We are doing this through intense learning, listening, acknowledging mistakes, and making changes along the way."[172]

During their meetings, RT members are constantly engaged in discussion and interact with city staff and facilitators.[173] These meetings provide regular opportunities for sharing feedback from their respective communities - feedback that can then be used to adapt the RVAgreen 2050 process to make it more inclusive, participatory, and transparent. As the plan continues to

[168] Anonymous (P2). (2021, March 8). Personal interview.

[169] USDN, 2019. Op. cit.

[170] Fisher, B. & Norrell, K. (2021, February 10). Personal interview.

[171] USDN, 2019. Op. cit., p. 15

[172] RVAgreen 2050. (n.d.). *Understanding Community Priorities*. City of Richmond. Retrieved April 14, 2021 from: https://www.rvagreen2050.com/understanding-community-priorities

[173] Walden, E. & Freeman, M. (2021, February 22). Personal interview.

evolve and progress, the Office of Sustainability staff continue to provide relevant information about the plan to the general public through their opt-in email updates, virtual one-on-one meetings with sustainability staff,[174] the RVAgreen2050 YouTube channel, and their plan website, further supporting transparency in the process.

The consultative facilitators have supported transparency by administering educational training that equipped RT members with the necessary information to communicate about and participate in the decision making process, guided RT members in creating an overarching strategy for the RT to use moving forward in the planning process, and assisted in establishing shared language around equity for the group. One of the best practices identified by the USDN for third party facilitators in the equitable decision making process is that these facilitators should prepare a group such as the RVAgreen 2050 RT to make strategic decisions that are backed by shared principles and practices.[175] The training and shared language guidance that the facilitators provided served as these shared practices and principles, which the RT members could utilize to make fully informed decisions in the RVAgreen 2050 process.

RT members created transparency around their representation of the greater Richmond community by completing initial demographic surveys and sharing the survey results. The survey results clearly demonstrated that the RT and the Working Groups on which RT members serve are not a direct representation of the demographics of Richmond overall.[176] Despite this disconnect, based on our interviews with four current members, RT members seem to be in agreement about their responsibility to the communities of Richmond: listening to community members, giving a voice to and advocating for historically marginalized community members, facilitating community participation in the decision making process, and holding those in positions of leadership accountable. RT members and city staff both openly acknowledge that the demographic makeup of the RT is not a mirror image of Richmond's overall demographics, and this "inexact" representation does not appear to hinder the RT's commitment to transparency and to their overall role in the equitable decision-making process.

Accountability

Accountability measures ensure that all stakeholders are adhering to the principles of equitable, community-driven planning. Local governments must be accountable for meaningfully incorporating community voice and input into the final plan to move beyond performative inclusion to reach a shared leadership over the plan and its development. A core belief of the USDN is that community stakeholders must "be able to trust the planning process

[174] City of Richmond RVAgreen 2050. (n.d.). Get Involved with RVAgreen 2050 webpage. Retrieved April 4, 2021 from: https://www.rvagreen2050.com/participate

[175] USDN, 2019. Op. cit., p. 15

[176] Roundtable Discussion Slides 1.5.2021. (2021, January 5). Considerations for Community Engagement Discussion. City of Richmond. Retrieved April 4, 2021, from: https://www.rva.gov/sites/default/files/2021-01/Roundtable%20Discussion%20Slides%201.5.2021.pdf

to fully participate."[177] In an equitable process, accountability helps to foster this trust by defining clear and consistent expectations from all stakeholders, but particularly from the city, around how to make and implement a shared vision.

Most of the best practices related to accountability in equitable decision-making advocate for the establishment of some version of community advisory committee that is charged with overseeing both the process and the implementation of a community-driven planning process. These community committees are founded on the principle that they will hold the city accountable for promoting equity equally alongside its climate goals.[178] The Office of Sustainability makes explicit this role by placing the RT at the center of the five working groups and defining its responsibilities as "shaping [the] planning process and content."[179] Specifically, it holds the RT members responsible for serving "as liaisons to ensure community needs and assets are integrated into the planning process."[180] Conversations with city staff make clear that the expectation is for the RT to have the "final say" in the plan's strategies and language.[181] In these ways, the RVAgreen 2050 process has committed to holding itself accountable through a transparent power-sharing relationship with the RT that does not subordinate the RT's role relative to the city's.

This practice aligns with the USDN's recommendations and also reflects how previous equity-centered climate action plans in peer cities were developed. For example, the City of Seattle convened the Green Ribbon Commission (GRC) to sit in between the Technical Advisory Groups (TAG) and the city's implementation of climate adaptation and resilience strategies. Its 2013 Climate Action Plan, highlighted as exemplary by the USDN, charges the GRC with considering the TAG recommendations and "adding their own ideas and perspective to develop recommendations in the sectors considered by the TAGs."[182] The RVAgreen 2050 RT serves the same purpose, and the language that the Office of Sustainability uses to describe its role mirrors best practices espoused by the USDN and that is reflected in prior high-quality and equity-driven plans.

The Office of Sustainability has also identified several milestones across its pre-planning and plan development work that seek to keep the city accountable for continuing to incorporate community voice, with the goal of fostering trust in the process. By centering RVAgreen 2050

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[177] USDN, 2017. Op. cit., p. 24.

[178] Ibid.

[179] RVAgreen 2050 Introduction. (2020, October 27). *Racial Equity and Environmental Justice Roundtable: Meeting #1*. City of Richmond. Retrieved March 31, 2021, from: https://www.rva.gov/sites/default/files/2020-10/RVAgreen%202050%20Introduction.pdf

[180] Roundtable Discussion Slides 1.5.2021. (2021, January 5). *Considerations for Community Engagement Discussion.* City of Richmond. Retrieved March 31, 2021, from: https://www.rva.gov/sites/default/files/2021-01/Roundtable%20Discussion%20Slides%201.5.2021.pdf

[181] Fisher, B. & Norrell, K. (2021, February 10). Personal interview.

[182] City of Seattle. (2013). *Seattle Climate Action Plan.* Seattle Office of Sustainability & Environment. http://www.seattle.gov/Documents/Departments/Environment/ClimateChange/2013_CAP_20130612.pdf

around the seven community priorities, the staff has made a public commitment to honor these priorities within the plan itself. The website states,

> *"We will communicate what we heard and simultaneously make sure RVAgreen 2050 is adequately addressing community priorities."*[183]

Our evaluation of the process to-date has not identified any evidence to suggest that this commitment is disingenuous. The facilitators charged with leading the RT meetings shared that they continually ask members to consider how the content and information shared in the RT discussions relates to them personally and to their communities.[184] This constant (re)alignment and reconciliation of the Office of Sustainability's climate agenda with the community's values and lived experiences by way of third-party moderation (via the facilitators) ensures that the office remains accountable to the community. This was a critical shortcoming in Seattle's plan, for example, where feedback indicated that the city's ultimate decision-making was not directly accountable to the communities because members of the GRC were handpicked and no third-party stakeholders were involved.[185] Because representatives from the Office of Sustainability join each moderated RT meeting, these discussions reinforce the city's accountability for achieving progress toward community priorities and remove any possible deniability or ignorance of the community's feedback. RT meetings thus serve as the nexus for community members, city staff, and outside (i.e., neutral) actors to convene regularly, a critical element of a successful equitable decision-making process.

Finally, the RVAgreen 2050 Equity Tool serves as a tangible framework for holding the Office of Sustainability and the Technical Working Groups accountable for considering the community priorities. This is an essential element of accountability in equitable decision-making espoused by the USDN, which tasks planners to "scan strategies to ensure equity goals are not subordinate to climate goals."[186] This tool, which asks key questions related to each community priority, was developed by the RT and shared with the Technical Working Groups as they developed draft strategies. In proposing this instrument, the Office of Sustainability prompted the RT by asking:

> *"How can we ensure that making decisions related to policy, planning, programming, and budgeting advance racial equity and shared prosperity?"*[187]

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[183] RVAgreen 2050. (n.d.). *RVAgreen 2050: Understanding Community Priorities*. City of Richmond. Retrieved March 31, 2021, from: https://www.rvagreen2050.com/understanding-community-priorities

[184] Walden, E. & Freeman, M. (2021, February 22). Personal interview.

[185] USDN, 2019. Op. cit., p. 25.

[186] USDN, 2017. Op. cit., p. 24.

[187] Roundtable Discussion Slides 11.24.2020. (2020, November 24). *RVAgreen 2050 Vision Statement.* City of Richmond. Retrieved March 31, 2021, from: https://www.rva.gov/sites/default/files/2020-11/Roundtable%2011.24.2020_0.pdf

Importantly, the Office of Sustainability committed to using the Equity Tool as both a "product and a process."[188] It was framed by the office as a product to use to "evaluate the extent to which proposed climate action and resilience strategies...prioritize equity as it related to each community priority" and as a process in that it embeds "a practice of equity thinking through creating and using the tool."[189] Unlike the shortcomings of other climate plans, this Equity Tool helps to ensure that the city and other key policy makers are ultimately accountable to the community. For example, Washington D.C.'s Ward 7 Equity Advisory Group (EAG) provided the city with direct feedback on steps to take to create a more equitable decision-making process, but no accountability mechanisms were established by Washington D.C. to assure EAG members that their priorities would be considered and set up.[190] The USDN cites the D.C. example as a city that has not meaningfully transferred decision-making ownership to communities. By contrast, RVAgreen 2050's Equity Tool puts explicit mechanisms in place for diffusing the community's voice into every aspect of the planning process in a formalized manner and provides a tangible document that holds the Office of Sustainability accountable to the community.

What is working well with respect to RVAGreen 2050's equitable decision-making framework?			
	Office of Sustainability	Consultative Facilitators	Roundtable Members
Power Sharing	• Used feedback from community partners to create initial framework for the planning process • Hired consultants for equity training to ensure common/understood language • Created virtual ambassador program and resident roundtable to center community engagement and input into planning process • Invited representatives from other city agencies to be on technical working groups	• Co-created the curriculum on meetings with city staff • Helped create shared language for equity training purposes • Worked with roundtable members to develop community engagement strategies specific for each member's context	• Dual participation across roundtable and working groups • Presumed to have the "final say" in strategy development • Given the responsibility of curating a community-engagement plan for their respective communities

[188] RVAgreen 2050 Waste Working Group Meeting Slides 1.7.2021. (2021, January 7). *RVAgreen 2050 Waste Technical Working Group.* Retrieved March 31, 2021, from: https://www.rva.gov/sites/default/files/2021-01/RVAgreen%202050%20Waste%20Working%20Group%20Equity%20Tool%201.7.2021.pdf

[189] Ibid.

[190] District of Columbia. (2018). *Recommendations from the Equity Advisory Group in Far NE Ward 7.* Georgetown Climate Center and District Department of Energy and Environment. https://www.georgetownclimate.org/files/report/eag_recommendations_web_8.20.18.pdf

Transparency	• Created a flexible planning process that can change and pivot according to stakeholder feedback • Provides detailed and publicly accessible information about the planning process and updates via the RVAgreen 2050 website	• Administered training and provided an overarching strategy for the Roundtable to move forward • Created a shared language surrounding the idea of equity to foster transparency in discussions	• Completed initial demographic surveys to identify ways in which the Roundtable was representative of the broader Richmond community
Accountability	• Started the process by acknowledging the city's role in perpetuating a history of systemic racism and discrimination • Established the Roundtable with the purpose of it serving as an intermediary between the community, technical working groups, and local government • Publicly committed to addressing the community priorities in the RVAgreen 2050 plan	• Facilitated regular discussions that prompted Roundtable members to reflect on how new proposals related to them personally and to their communities • Trained Roundtable members on how to make strategic contributions to the climate plan and taught them the language needed to hold the city and their own communities accountable	• Participated as both members of the Roundtable and of a Technical Working Group to ensure that climate and equity goals were considered equally • Defined individual strategies that would work well within their communities for sharing and gathering feedback on the proposed plan • Developed the RVAgreen 2050 Equity Tool to ensure alignment between community priorities and climate plan

Opportunities for Next Steps

Power Sharing

Sharing power requires government agencies to actively pursue transparency, accountability, and equitable engagement throughout every phase of the planning process. The Office of Sustainability has made sincere efforts to acknowledge and address previous inequities that have led to current environmental injustices, and to provide inclusive opportunities for involvement in this planning process.

City staff are transparent about the demographics of the roundtable and working group not being entirely representative of Richmonds rich diversity. Third party consultants have identified the need for a reflective RT representation that is inclusive of all of Richmond's residents, however adding more residents to the RT this late in the process is not a possibility.[191] The working groups are less representative of Richmond than the RT. Some RT members that were interviewed identified a key to making the planning process more equitable is having a more accurate representation in both the working groups and the RT. One RT member even suggested more extensive equity training for those that have not had a lived experience that has been marginalized.[192] All of the RT members that were interviewed

[191] Walden, E. & Freeman, M. (2021, February 22). Personal interview.

[192] Anonymous (P1). (2021, March 8). Personal interview.

expressed gratitude for being a part of the decision making process and to the Office of Sustainability for conducting a planning process that is community driven.

Transparency

Creating and maintaining transparency can be challenging. Local government staff, facilitators of the decision-making process, and any participating committees and partner organizations must commit to transparency around information sharing and the nature of the decision-making process itself. The Office of Sustainability staff face a few potential challenges to achieving transparency in their effort to support equitable decisions making, primarily related to expanding community engagement, defining roles for existing stakeholders in the next phase of the plan, and creating a strategy to implement the plan consistently across city departments. There is, according to a RT member, a potential dearth of engagement with two groups of community members: those who do not have access to the internet and those who are not already a part of the advocacy community here in Richmond.[193] City staff can work collaboratively with RT members and RVAgreen Ambassadors to identify more inclusive strategies that target these communities. Along these same lines, city staff can leverage the expertise and enthusiasm of the Ambassadors to achieve their engagement goals and increase transparency by engaging with a broader swath of Richmond residents, but should first define or redefine as necessary the role of the Ambassador in the plan development and plan implementation phases. In addition to creating a clear and shared understanding with Ambassadors, city staff should ensure that they have the educational resources needed to create transparent communication channels with these community members. Lastly, this shared understanding of respective roles in the implementation and development phases should extend to city departments who will participate in rolling out the plan in the future. If departments understand their role in moving the plan forward and are supported in doing so, there will be transparency across departments and department staff will be equipped to participate in RVAgreen's equitable decision making process.

As RVAgreen 2050 shifts from plan development to implementation, the RT will require additional training and support from facilitators. A member of the RT suggested that equipping members and Ambassadors with the data and/or academic information to demonstrate why the needs expressed by the community matter would make the overall RVAgreen 2050 planning process more equitable.[194] The USDN posits that a truly community-driven process requires a transparent two-way channel of communication to support advancing solutions to complex problems.[195] Facilitators should offer their expertise to address any technical knowledge gaps that the RT members identify, so that members feel equipped to effectively discuss complex community needs with working group members and city staff, creating transparency in how information moves from the community to other stakeholders in the equitable decision making process.

[193] Anonymous (P4). (2021, March 12). Personal interview.

[194] Anonymous (P2). (2021, March 8). Personal interview.

[195] USDN, 2017. p. 25.

RT members are set to embark on a period of community outreach and engagement in 2021 and 2022. Since shared understanding is integral to maintaining transparency, a critical action to ensure that this outreach process is transparent is to identify the purpose, goal(s) and intended outcome(s) for the RT's outreach efforts. The city staff, facilitators, and RT members should come to a consensus when establishing these and then share them with the community members who are providing feedback. While RT members created their own respective community engagement plans about who specifically they will engage and how,[196] which may differ among members, there is not yet a system in place to track the community feedback collected during this period. Creating a singular system in which feedback is tracked consistently supports transparency because the feedback will be centrally available and accessible. Additionally, feedback will all be logged in the same way, helping to ensure that feedback is reviewed and considered equitably in the decision making process. City staff are utilizing the Virginia Community Voice Blueprint to guide their RVAGreen 2050 engagement efforts.[197] The RT may want to consider this same framework for organizing and cataloging feedback data. The Blueprint framework is meant to support a more inclusive and equitable decision making process.[198] The Blueprint suggests using surveys and interviews to collect three types of information - lived experience, historical context and disaggregated data (i.e. data at the neighborhood level) - and then combine this information to create "data storytelling".[199] This framework would not only help organize the community feedback collected, but also how to share out the feedback to other stakeholders. This information-sharing across all stakeholder groups is critical to creating transparency in decision making.

Accountability

Having accountability measures in place from the onset provides a level of assurance to the community that city staff are committed to an equitable process and that they have identified tangible metrics to ensure adherence to that framework. In turn, this can foster more trust in the planning process because it provides specific criteria for community members to consult to evaluate the degree to which the city is upholding its promises.[200] Importantly, accountability in equitable decision-making spans the entire planning process from initiation to implementation. Local governments need to be accountable for fully incorporating community voice into the development of a climate action plan, but there also needs to be metrics and protections in place to ensure that the plan is implemented in accordance with equity principles as well.

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[196] Walden, E. & Freeman, M. (2021, February 22). Personal interview.

[197] RVAgreen 2050. (n.d.). *Understanding Community Priorities*. City of Richmond. Retrieved April 14, 2021 from: https://www.rvagreen2050.com/understanding-community-priorities

[198] Virginia Community Voice. (n.d.). The Blueprint. p. 13. Retrieved April 4, 2021, from: https://vacommunityvoice.org/blueprint

[199] Virginia Community Voice. (n.d.). The Blueprint. p. 6-12. Retrieved April 4, 2021, from: https://vacommunityvoice.org/blueprint

[200] USDN, 2017. Op. cit.

The RVAgreen 2050 process is mapped out to include adoption and implementation of the plan, which suggests that the principles of equity and shared decision-making will translate from the planning stage to the implementation stage. Across 2022, the Office of Sustainability plans to seek community feedback on the final plan, go to the CAO, mayor, and city council for approval, and support the implementation projects in frontline communities.[201] Many of the determinations for the office's ultimate accountability to the community will occur during these stages of the process. While the Office of Sustainability has been accountable to the RT, and by extension to the broader Richmond community, during the planning process, it remains to be seen if and how they will institute measures to continue to be beholden to the community.

With no plans as-of-yet published on how the office will be accountable to the equity principles of its climate action plan, this is an area that we would recommend further information be provided. An appropriate model to follow is the Seattle Office of Sustainability & Environment's Environmental Justice Committee (EJC). THe EJC was convened in 2017, two years after the adoption of the city's Climate Action Plan, to ensure continued participation and influence of frontline communities. The EJC developed the office's Equity and Environment agenda and "centers community ownership in decision-making" as a core mandate.[202] The committee advocates for "strong accountability" that includes "ongoing oversight of government and other entities to address the negative impacts they have experienced."[203] The EJC continues to hold the City of Seattle accountable for upholding its promise to center community ownership of the decision-making process; for example, in December 2020 it released a report outlining community priorities for equity and environment in light of the COVID-19 pandemic.

> *"We believe that affected communities deserve strong, accountable, transparent, accessible, and culturally appropriate solutions that include ongoing oversight of government and other entities to address the negative impacts they have experienced."*

Despite claims that the RT will have the final say in the plan's development, no explicit mention of this authority was identified. In fact, in speaking with one member of the RT, they indicated that they "wouldn't classify" the RT as having the final say, and instead perceived it serving in a more editing and refining capacity.[204] This demonstrates a major gap in the decision-making power of the RT, and the lack of information about its ultimate authority leaves space for the Office of Sustainability to be unaccountable. This ambiguity is further exacerbated by the amorphous nature of the RT's responsibilities. Numerous RT members expressed confusion over the goals, roles, and duties of the Roundtable, and said that they only became clear after

[201] RVAgreen 2050. (n.d.). *RVAgreen 2050: Adopt and Implement*. City of Richmond. Retrieved March 31, 2021, from: https://www.rvagreen2050.com/adopt-and-implement

[202] Equity and Environment (2020). *Environmental Justice Committee*. City of Seattle. Retrieved April 1, 2021, from: https://www.seattle.gov/environment/equity-and-environment/environmental-justice-committee

[203] City of Seattle. (2017). *Equity & Environment Agenda.* Seattle Office of Sustainability & Environment. http://www.seattle.gov/Documents/Departments/OSE/SeattleEquityAgenda.pdf

[204] Anonymous (P4). (2021, March 22). Personal interview.

several meetings.[205] Moving forward, we urge the Office of Sustainability to better define and make explicit the roles and responsibilities of the RT as a way to hold themselves publicly accountable for abdicating final authority to the community.

What opportunities exist for RVAgreen 2050 to better foster an equitable decision-making process?			
	Office of Sustainability	Consultative Facilitators	Roundtable Members
Power Sharing	• Explore intergovernmental partnerships with other city agencies to help have a more cohesive approach to climate change planning • Develop metrics to track progress of roundtable members community engagement plan • With aid from consultants, consider how to make roundtable and working groups more representative of the communities this plan intends to serve	• Provide a more in-depth equity training option for technical working group members	• None
Transparency	• Develop strategies to reach out to and share information to those who are not already part of the local advocacy realm, and community members who do not have access to the internet • Identify/clarify the role of Ambassadors in the next phase of the plan • Create a cohesive strategy to implement the plan across city departments	• Based feedback from the RT and city staff, identify additional training opportunities so that RT members have ongoing support • As focus shifts to strategy development and plan implementation, ensure that the language used in communications can be understood by technical experts and community members	• Collaboratively develop a system for RT members to keep track of feedback from their community outreach • With city staff and facilitators, identify the purpose, goal(s) and intended outcome(s) for the outreach phase

[205] [1] Anonymous (P1). (2021, March 8). Personal interview. [2] Anonymous (P3). (2021, March 11). Personal interview.

Accountability	• Convene a standing environmental justice committee to oversee roll-out of the plan and ensure equity continues to be centered • Better define the RT's duties and final authority using language that is clear, accessible, and consistent • Identify any potential institutional or structural barriers that may impede the implementation of equity goals	• Participate in the ongoing community outreach to hold Roundtable members accountable for engaging with their communities	• None

E. Build Support

By increasing public awareness and support for RVAgreen2050, both the Office of Sustainability and community will benefit from greater understanding and awareness of the goals and expectations of the RVAgreen2050 plan. Doing so will result in more equitable processes and outcomes by ensuring that voices of underserved community members are not only heard but understood and valued in the planning process. Given the long history of racial bias that planning has had, the centering of equity in the process by greater understanding is a crucial step to right the wrongs of the past as well as prevent new hardships related to climate.

Assessment Indicators

In this section, we focus on six assessment indicators to determine how RVAgreen 2050 is performing with respect to building support for its mission among stakeholders. These assessment indicators are: mutual learning, participants' needs, realistic timeline, transparency, diversity, and engagement.

Assessment Indicator	Definition
Mutual Learning	Mutual learning allows for ideas to be shared and developed across different groups of people to provide the most benefits possible to all parties. While it can be done in many different ways, mutual learning often happens when community members, facilitators, and city staff meet and discuss ideas, commenting on, critiquing, and commending throughout the process to improve ideas.
Participant's Needs	Everyone involved in the planning process has different requirements and needs, whether they be services needed in order to participate or planning needs that must be cared for. Understanding and addressing any and all needs of participants is essential to ensure that people can fully participate in the process, unhindered by pressing burdens that would otherwise prevent their inclusion in the process.
Realistic Timeline	Throughout the planning process the amount of time required for a task must be taken into account. The planner and facilitator must ensure an ample amount of time is set aside looking through a practical lense. The established timeline should have a bit of flexibility to accommodate for tasks taking longer than originally planned.
Transparency	Transparency is important to the RVAgreen2050 mission as it seeks to mend the relationships with communities that were marginalized in past plans. Transparency and clarity of purpose helps build support and trust. Here we define transparency to mean the clarity and openness.
Diversity	The RVAgreen team must work to ensure that both the Roundtables and Working Groups include representatives from all groups within the Richmond communities. Diversity is tremendously important to ensure all races and ethnic groups are represented in the process.
Engagement	As RVAgreen2050 moves into the Community Engagement Phase of the project, we examine the plans for future community engagement efforts as well as the

	engagement that RVAGreen2050 has done with the Roundtable and working group members. Here we will use engagement to mean active participation of stakeholders.

Build on What's Working

Mutual Learning

RVAgreen 2050 has involved mutual learning across all levels of those involved in the process. The Office of Sustainability chose to center equity in their plan, and therefore began the process with listening to community members to understand what equity looked like for different people. This represents an important step, as many members of the department have advanced degrees, which is not representative of the city as a whole, and therefore are likely to have different priorities than the majority. The facilitators increased the background knowledge of the Roundtable (RT) members in equity, climate change, and city processes, thus building their individual capacities and allowing for greater engagement and participation from all members.

The greatest mutual learning comes from the RT members. Part of their role in the process has been to act as laypeople in their vetting of policies and word choice used, with one RT member saying that they found overly academic terminology and "don't understand that word. Like [the working group members] are not going to understand that this isn't translating because they're not in my shoes. So I can kind of speak up and ask the right questions".[206] This often occurred as RT members pointed out aspects that have been overlooked by working group members or by vetting whether or not the ideas put forward would translate well to actual community members. In interviews, RT members commented on how this helped them through the process, with one saying "I am learning so much so I want to make that clear as well. I'm not just going in there and shaking my finger and saying you have to do this; you have to do that" indicating that they felt more capable of giving constructive comments.[207] Beyond that, RT members work collaboratively with the other working group members to develop and add to ideas.

Participants' Needs

The priorities of RVAgreen 2050 were decided on by listening to what people were most concerned about in their communities, resulting in the seven community priorities for RVAgreen.[208] This demonstrates a clear desire to center the plan on real world community needs, as opposed to esoterically broad concerns like melting ice caps and carbon emissions. The selection of priorities places greater emphasis on the concerns of frontline community

[206] Anonymous (P3). (2021, March 15). Personal interview.

[207] Ibid.

[208] RVAgreen 2050. (n.d.). *RVAgreen 2050: Understanding Community Priorities*. City of Richmond. from: https://www.rvagreen2050.com/understanding-community-priorities

members, rather than more vocal people with expert knowledge who are often disproportionately represented in environmentalism movements.

Working group members have different needs which must be taken care of in order to promote high levels of meaningful participation. RT members in underrepresented communities were given the opportunity to receive grants of up to $5000 for their work to incentivize participation and help to overcome barriers to participation.[209] This grant money potentially opens the door to participation for people who are unable to justify the time commitment due to some financial burdens. While all members were expected to pay attention and participate at meetings, online meetings provided a unique possibility for members to be at home and tend to things as needed. One RT member mentioned that cooking dinner during a meeting was not at all unusual, even being a relationship building activity as members would casually ask one another what they are cooking.[210] This flexibility permits RT members to care for their kids and multitask if needed, which would not have been possible in a traditional brick and mortar community meeting.

Realistic Timeline

When developing the timeline and schedule for a planning process, planners and facilitators must determine what tasks are needed and carefully calculate the amount of time required to complete each task. The many factors that must be taken into account have to be analyzed to determine just how much of an effect that will have overall. These factors included the number of staff members, the budget allotted for the process, and building some contingency for unforeseeable set back, such as COVID-19.

The RVAgreen 2050 team has been sticking relatively well to the timeline they set in the beginning of the process. The schedule has been very flexible to accommodate for items that may have taken longer than originally scheduled. COVID-19 has placed a strain on the process now that all communication and training for the working group and RT are completely virtual. To accommodate and ensure the schedule is adhered to as best as possible, the RT held a meeting specifically to review previous discussions, looking at the time line to see if the process is on track, comparing and pulling data from other cities, and establishing the methodology that will be used moving forward. The RT meetings are shared via Youtube allowing for members who could not make the meeting update on the latest information and still provide their own feedback.

Transparency

Throughout interviews with RT members, City of Richmond staff, and facilitators, it was clear that stakeholders at these levels were committed to an equity centered process. This commitment to equity was laid out and fully explained at the beginning of the process to

[209] RVAgreen2050 (2020). *RVAgreen 2050 Roundtable and Working Groups Application*

[210] Anonymous (P4). (2021, March 22). Personal interview.

ensure all members were on the same page. This led to RT members, in particular, feeling empowered to speak out when a statement, process, or suggestion is not considering equity.

Furthermore, with respect to clarity, the City of Richmond staff and facilitator team set a standard early on to cultivate a culture of understanding with respect to language. This included encouraging team members to use accessible and clear language and as a result created an atmosphere in which team members felt empowered to ask for clarification when a term was used that they were not familiar with, or to encourage a language change to ensure the message would be well received and understood by the community. RT members confirmed this in interviews, citing specific examples of asking questions or voicing concern and having their suggestions taken into consideration. For example, one RT member suggested shifting language from "zip codes" to "neighborhoods" when discussing areas of the city to acknowledge the variety of experiences in any given zip code.[211] This point was taken and language in conversations moving forward was adjusted.

If RVAgreen 2050 wants to be transparent to the community stakeholders in this planning process, then as important as the message itself is the ability of that message to be fully understood by community members. We encourage RVAgreen2050 to build on the successes it has accomplished so far and continue to be open and clear that they are centering equity and why as well as continuing to use accessible and clear language so community members can not only understand the message, but feel that the effort to get them involved is genuine.

Diversity

Regardless of how well the process is developed, the importance of diversity within the planning process ensures the unique needs of the community are met. The lack of diversity can severely skew the data collected which can lead to the development of ineffective recommendations at the end of the report. The time and funds utilized for the process are spent on a process that will not be used. This only further delays the ability for mitigation of the issues within the community.

The RVAgreen team provided numerous opportunities for community members to get involved with the process, from email updates and surveys to 30 minute one on one sessions with a member of the RVAgreen team. The "Get Involved" section of the RVAgreen2050 webpage outlines the many ways to get involved.[212] The many available avenues for engagement are offered to ensure all members feel comfortable getting involved and communicating with the RVAgreen team. In this communication, the consistent language is developed to be transparent and inclusive for all to understand. In addition, the members RT were picked to ensure that every ward in the city would have a representative, with the more disadvantaged wards getting extra members as an insurance that every community's voice is heard. The team expressed that

[211] Anonymous (P2). (2021, March 10). Personal interview.

[212] City of Richmond RVAgreen 2050. (n.d.). Get Involved with RVAgreen 2050 webpage. Retrieved April 10, 2021 from: https://www.rvagreen2050.com/participate

their "targeted universal strategy is inclusive of the needs of both dominant and marginalized groups but pays particular attention to the situation of the marginalized group."[213]

Engagement

Office of Sustainability staff and RT members are very engaged in the planning process. This can be seen through their passion in interviews as well as in the use of resources provided to them. RT members feel that their ideas are being heard and taken seriously, with many members citing in interviews specific examples of their ideas or feedback leading to real time change.[214] This involvement encourages the members to feel engaged, creating more buy in and building support for the planning process overall.

The RVAgreen 2050 team has plans to reach out to the community in many different ways, including social media, emails, and community meetings.[215] One staff member spoke of acknowledging that one size does not fit all with respect to communication, and this is the right attitude to have with respect to outreach.[216] Determining how community members communicate and reaching out to them in ways that are easily accessible will be the key to getting more community involvement.

As RVAgreen 2050 is moving more fully into the Community Engagement Phase, they have also equipped the RT members, who will be the face of the planning campaign, to go out into the community to engage residents. What has been successful to this point, having not yet gathered data on the implementation of community outreach, is that the RT members have received training from facilitators with respect to communication techniques and strategies. RT members have been given the tools to answer the "so what?" and "why should I care?" questions from community members, but it will be important to RVAGreen2050 to adjust their toolkit as the community outreach gets underway and be prepared to pivot if the chosen path isn't working.

What is working well with respect to RVAgreen 2050's process of building support?			
	Office of Sustainability	Consultative Facilitators	Roundtable Members
Mutual Learning	• Listening sessions used by RVAgreen 2050 to understand the desires and priorities of frontline organizations, will engage with frontline	• RT members receive training from facilitators to get everyone at a level at which they can contribute to idea development	• RT members develop ideas collaboratively by adding and contributing to ideas • RT members point out blind spots that have not been

[213] Anonymous (P1).(2021, February 17). Personal interview.

[214] Anonymous (P7). (2021, March 10). Personal interview.

[215] City of Richmond RVAgreen 2050. (n.d.). Get Involved with RVAgreen 2050 webpage. Retrieved April 10, 2021 from: https://www.rvagreen2050.com/participate

[216] Fisher, B. & Norell, K. (2021, February 15). Personal Interview. [Zoom Call].

	community members directly in following phases		noticed by the city and advocate for their communities ● RT vets ideas that the city has come up with to determine whether they will be effective and well received ● RT meetings are used to get feedback from members and to do consensus building
Participant's Needs	● Participants can be paid up to $5000 for their work on the RT, less for roles that require less work ● 7 RVAgreen2050 priorities chosen based on what city officials heard from residents	● Everyone in process is instructed to emphasis the tangible effects of climate change (Urban Heat Island, Flooding, etc.) as opposed to more abstract concepts (Such as carbon emissions) ● Top criteria for selection on RT are ability to reach hard to reach communities and proven experience doing it ● RT Member capacity increased by training and homework in the earlier part of process, which they will then use to increase the capacity of their own communities	● None
Realistic Timeline	● None	● None	● A RT meeting was held to review previous discussions, looking at the time line to see if the process is on track, comparing and pulling data from other cities, and establishing the methodology that will be used moving forward. ● Kendra expressed the schedule has been very flexible thus far. ● Sharing the videos via youtube allows for participants who missed the meeting to review and be updated.
Transparency	● The importance of equity was explained at the outset and it was widely accepted as the priority. ● Building out consistent language to be inclusive and transparent.	● Trainers worked to get everyone on the same page so there could be effective communication, with respect to common language and consistent messaging.	● None
Diversity	● It was expressed that having multiple ways the community could communicate, acknowledges that there's not a "one size fits all" solution to communicating with members of the community.	● The RT members were educated on how to answer the "so what?" and "how does that impact me?" questions that might arise.	● The members were picked for the RT to ensure that every city council district would have a representative, with the more disadvantaged wards getting extra members as an insurance in case anyone dropped out.

	• The team is working to ensure consistent language to be inclusive and transparent. • The RVAGreen2050 team has made fair efforts to get a good cross-section of representation from RVA and professionals.		
Engagement	• Variety of community communication, including social media, emails, meetings, etc. .	• Facilitators trained the team on community engagement, what principles to hold themselves to, and how to develop community engagement strategies. • Facilitators focused on equipping the RT members with communication tools.	• RT members feel that their ideas are heard and taken seriously. Many members have cited specific examples of their suggestions being implemented in future meetings.

Opportunities for Next Steps

Mutual Learning

The mutual learning between working group members and RT members was somewhat disrupted on multiple occasions by a lack of equity training on the part of working group members. While the impromptu equity training provided by RT members when this was brought up was perceived by some to simply be a role of RT members and even an opportunity to educate, the lack of training on the part of expert working group members did put RT members in a potentially uncomfortable situation. In one interview, a RT member stated "it can be really insulting, like the idea of having to teach somebody how to respect you. Like you're a grown adult, you're coming to the table behind on this information. It's your job to catch up."[217] By providing more equity training resources for all group members, this situation can be avoided while also allowing for higher level and equity focused ideas from all members instead of placing so much of the equity-centering burden onto RT members.

Participants' Needs

At this stage in the planning process, there are many opportunities for growth in meeting participants' needs in future steps. The most pressing concern is that of the digital divide. While this has been mentioned, there is little evidence showing how the process worked to include people without reliable access to the internet. In the times of COVID-19, this divide is admittedly a hurdle to overcome, but given the disparities in who is most affected by the pandemic, it is crucial that these voices in particular be heard. Greater access to the internet has been shown to result in higher rates of public participation and public knowledge, and would therefore amplify these voices.[218] The shortcomings of the digital outreach strategies

[217] Anonymous (P2). (2021, March 10). Personal interview.

[218] Sylvester, D and McGlynn, A. (2010). *The Digital Divide, Political Participation, and Race.* Social Science Computer Review

that the pandemic has demanded, though, surpasses simply having internet access. Many people are not as comfortable sharing their opinions online as they would be in person, which can slow mutual learning processes as less information is brought up by community members.

As vaccination rates increase and in-person activities can be held safely, the RVAgreen 2050 team will be presented with a host of opportunities in how they wish to take advantage of new capabilities. Beyond including the voices of those without internet access, outreach strategies can be implemented to meet more physical needs of members. This can be as simple as providing food and taking place in ADA-compliant facilities, as was the case in Indianapolis, or more proactive approaches, such as "go to them" activities implemented in Bend, Oregon.[219]

Realistic Timeline

In establishing a realistic timeline, as expressed before, flexibility and contingency should be built into the schedule but dates should still be adhered to as best as possible. Public processes are often confined to tight timeless and budgeting constraints that necessitate limiting community engagement[220]. With the contingency built in, the potential for missed deadlines are reduced allowing for a smoother process. Expressing dates on the project website will also allow for citizens and other interested parties who can not or choose not to directly be a part of the process the opportunity to follow along with the process more closely.

Providing specific dates can be difficult with regards to schedule changes or tasks taking longer than expected. An alternative to dates is an implementation guide or chart showing the ways in which the items being developed will be implemented. The City of Portland developed an additional Climate Equity Implementation guide that provides a framework for evaluating the actions in relation to the objectives that were developed. A document similar to this or a section within the plan outlining the plans for implementation. This is something to keep in mind heading into the draft strategies section of the process.

Transparency

There are some opportunities for improvement in the RVAgreen 2050 plan with respect to transparency. The role of the Ambassadors is not very clear. While the website has some good tools for Ambassadors, it is not clear what exactly an Ambassador would do.[221] Improvements to the website with respect to Ambassador expectations (i.e. would they be directly contacting community members, are there metrics you expect them to hit, are they required to attend meetings, etc.), may help get more community members involved as Ambassadors and improve transparency with respect to that program. Providence's Race and Environmental Justice Committee faced a similar problem with respect to expectations of different roles and

[219] Fisher, B. (2021). Centering Equity in CAP - Best Practices and Examples. RVAgreen2050.

[220] Yien, T., Yurkovich, E., Grabowski, L., & Altshuler, B. (2017). USDN Guide to Equitable Community Driven Climate Preparedness. *Urban Sustainability Directors Network Innovation Fund*, 1–68.

[221] Virtual ambassador program. (n.d.). Retrieved April 10, 2021, from https://www.rvagreen2050.com/ambassador-program

communicating those expectations. They responded by developing and publishing role descriptions and expectations of all stakeholders.[222]

Another opportunity for improvement is with respect to social media outlets and RVAgreen 2050. These outlets are opportunities for RVAgreen 2050 to reach community members that might not otherwise visit the website, or entice people to visit the website to dive deeper into the information available. Both the Facebook and Instagram accounts are largely limited to calls for input and invitations to events, but lack the transparency with respect to why community members should buy-in to this effort. What makes this round of planning different from past efforts? How is equity being centered? Why should community members get involved? Why do you need them to be involved? All of these questions pose an opportunity for you all to be transparent about your intentions. In particular, RVAgreen 2050 has been transparent on the website about the shortcomings of planning in the past with respect to inclusion of disenfranchised communities, but that conversation is largely absent from social media. RVAgreen2050 can look to Baltimore for examples of successful use of social media to drive home the equity message in a sustainability plan. Not only does Baltimore use social media to convey information to community members, but they also use it to encourage community members to communicate with the City, by using the #EveryStoryCounts, community members share what they're doing to "make Baltimore a stronger, more sustainable city." [223]

Finally, there is some confusion among RT members about various aspects of the RVAgreen 2050 process. For example, none of the RT members who also serve on Working Groups know how many people are on the Working Group.[224] Many were unsure how they ended up on the Working Group they were on.[225] One RT member also voiced confusion about the role of the RT moving forward once the community engagement begins and the foundation of the RVAGreen2050 process is set.[226] All of these issues can be easily cleared up with an information session. It's suggested that the Office of Sustainability staff periodically host meetings (or portions of meetings) with RT members specifically designated to answering outstanding questions.

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[222] Urban Sustainability Directors Network (USDN). (2019). From community engagement to ownership: Tools for the field with case studies of four municipal community-driven environmental and racial equity committees. Urban Sustainability Directors Network. https://www.usdn.org/uploads/cms/documents/community_engagement_to_ownership_-_tools_and_case_studies_final.pdf

[223] *Every story counts*. (n.d.). Baltimore Office of Sustainability. Retrieved May 3, 2021, from https://www.baltimoresustainability.org/every-story-counts/

[224] Anonymous (P1). (2021, March 8). Personal interview. Anonymous (P2). (2021, March 10). Personal interview. Anonymous (P3). (2021, March 15). Personal interview. Anonymous (P4). (2021, March 22). Personal interview.

[225] Anonymous (P1). (2021, March 8). Personal interview. Anonymous (P2). (2021, March 10). Personal interview. Anonymous (P3). (2021, March 15). Personal interview. Anonymous (P4). (2021, March 22). Personal interview.

[226] Anonymous (P4). (2021, March 22). Personal interview.

Diversity

The importance of diverse input through the planning process cannot be stressed enough. Establishing the engagement of all community members making sure all are represented and included in the process ensures the recommendations and strategies will be effective and provides changes that benefit everyone. Though due diligence was done to ensure all members of the community were represented, comments were made expressing that most of the respondents are white, middle-upper class, and 35-55 years old. We must ensure the group assembled at the planning table is as diverse as the communities it aims to reimagine and rebuild [227].

Due COVID-19, certain provisions are not applicable to the process which makes public involvement more difficult. In the review of the process thus far, suggestions and comments have been shared from individuals involved in the planning process that additional efforts to ensure diversity should have been taken. The digital interaction allows for contactless responses via the email and social media but it deprives the opportunity for individuals who lack access to the internet to be involved. This makes said community members inherently less powerful in the planning process during social distancing. This may be the cause of the lack of diversity from the comments received. Though it can become a financial burden, physical copies of the survey and other notification avenues should be provided to community members to overcome the barrier of lacking internet access. The community representatives should be responsible for notifying citizens of locations where the physical copies of this information can be obtained, or even distribute them to the community members directly.

Engagement

Echoing the same sentiment from the Transparency section, improved social media use would also positively impact RVAgreen 2050's engagement efforts with respect to building support. The RVAgreen 2050 Facebook page is largely limited to calls for input and invitations to events.[228] While this is important information to get to the community, reintroducing the RVAgreen 2050 concept periodically will help engage new community members. Try sharing this information via short videos from Office of Sustainability employees or RT members. Putting a face and voice to the effort will help community members feel more connected.

To this point in the process, many of the RVAgreen 2050 survey respondents have not been representative of the target communities the team is trying to reach.[229] To improve the survey respondent demographics, some RT members have suggested diversifying outreach and engagement techniques and we support this suggestion. A RT member proposed reaching out to community members that are already trusted in the community (i.e. churches, civic

[227] Moore, D. (2015). The Just City Essays: Urban Spaces and the Mattering of Black Lives. *He J.Max Bond Center on Design*, *1*, 18–20.

[228] RVAgreen 2050. (n.d.). Timeline [Facebook page]. Retrieved April 10, 2021, from https://www.facebook.com/rvagreen2050/

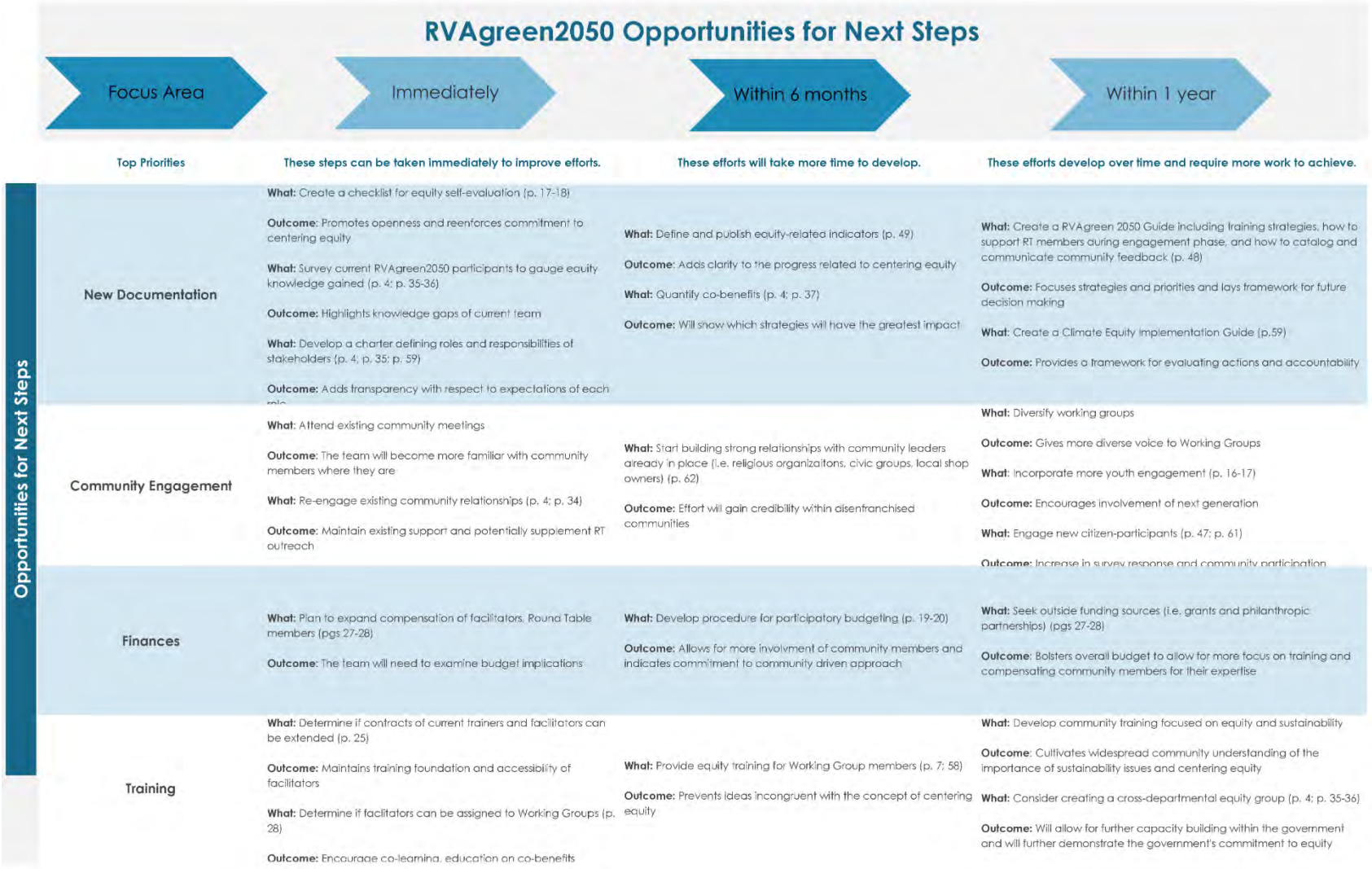
[229] Anonymous (P2). (2021, February 15). Personal interview.

organizations, religious groups, local shop owners) and creating buy-in with those community representatives. Trust between the RVAgreen 2050 team and the community can be built quickly on a firm foundation if RVAgreen 2050 can solicit support from these strong community pillars.

What opportunities exist for RVAgreen 2050's to better achieve building support?			
	Office of Sustainability	Consultative Facilitators	Roundtable Members
Mutual Learning	• None	• Better training of working group members so that RT members do not need to explain relatively basic equity concepts to them • Further explain importance of community engagement and equity training	• None
Participant's Needs	• The digital divide is recognized which makes it harder to reach non-connected people, but it is unclear what is being done to overcome this • Good outreach should emphasize meeting community members in their own neighborhoods and in places where they are comfortable. Zoom meetings hosted by the city are inherently not in a comfortable, familiar location, potentially making people less likely to share and participate • Post-covid, meetings should include things like free food and flexible times, days, and locations for meetings to encourage participation	• Better training at the beginning of the process and extra resources for those who are new to equity	• None
Realistic Timeline	• None	• None	• The RVAgreen2050 website should share specific dates as to when tasks will be taking place.
Transparency	• It's not clear exactly what the Ambassadors do. • Social media isn't very active with respect to original content (mainly sharing other accounts' information, blog isn't active).	• None	• None of the members seem to know why they were placed on the working groups they're in or how many people are on their working group. • The role of the RT moving forward isn't clear to some of the members.
Diversity	• People without reliable internet access inherently have less power in the planning process during social distancing	• None	• The working groups did not feel as representative as they should. They lack the diversity that should be included.

	• Was expressed that there is a lot that could be done to make it more equity and community centered. The survey respondents were mostly white, middle-upper class, and 35-55 years old. • If financially feasible, consider hiring specialists from other cities to express their opinions of different matters and allow RT and the working groups to have the final decision.		
Engagement	• Current survey respondents are not representative of Richmond, let alone the target demographics RVAgreen2050 would like to capture.	• None	• It's possible to have RT meetings both closed and open to the public.

Appendix A. Priority Recommendations Timeline



RVAgreen2050 Opportunities for Next Steps

Opportunities for Next Steps

Focus Area	Immediately	Within 6 months	Within 1 year
Top Priorities	These steps can be taken immediately to improve efforts.	These efforts will take more time to develop.	These efforts develop over time and require more work to achieve.
New Documentation	**What:** Create a checklist for equity self-evaluation (p. 17-18) **Outcome:** Promotes openness and reenforces commitment to centering equity **What:** Survey current RVAgreen2050 participants to gauge equity knowledge gained (p. 4; p. 35-36) **Outcome:** Highlights knowledge gaps of current team **What:** Develop a charter defining roles and responsibilities of stakeholders (p. 4; p. 35; p. 59) **Outcome:** Adds transparency with respect to expectations of each	**What:** Define and publish equity-related indicators (p. 49) **Outcome:** Adds clarity to the progress related to centering equity **What:** Quantify co-benefits (p. 4; p. 37) **Outcome:** Will show which strategies will have the greatest impact	**What:** Create a RVAgreen 2050 Guide including training strategies, how to support RT members during engagement phase, and how to catalog and communicate community feedback (p. 48) **Outcome:** Focuses strategies and priorities and lays framework for future decision making **What:** Create a Climate Equity Implementation Guide (p.59) **Outcome:** Provides a framework for evaluating actions and accountability
Community Engagement	**What:** Attend existing community meetings **Outcome:** The team will become more familiar with community members where they are **What:** Re-engage existing community relationships (p. 4; p. 34) **Outcome:** Maintain existing support and potentially supplement RT outreach	**What:** Start building strong relationships with community leaders already in place (i.e. religious organizaitons, civic groups, local shop owners) (p. 62) **Outcome:** Effort will gain credibility within disenfranchised communities	**What:** Diversify working groups **Outcome:** Gives more diverse voice to Working Groups **What:** Incorporate more youth engagement (p. 16-17) **Outcome:** Encourages involvement of next generation **What:** Engage new citizen-participants (p. 47; p. 61) **Outcome:** Increase in survey response and community participation
Finances	**What:** Plan to expand compensation of facilitators, Round Table members (pgs 27-28) **Outcome:** The team will need to examine budget implications	**What:** Develop procedure for participatory budgeting (p. 19-20) **Outcome:** Allows for more involvment of community members and indicates commitment to community driven approach	**What:** Seek outside funding sources (i.e. grants and philanthropic partnerships) (pgs 27-28) **Outcome:** Bolsters overall budget to allow for more focus on training and compensating community members for their expertise
Training	**What:** Determine if contracts of current trainers and facilitators can be extended (p. 25) **Outcome:** Maintains training foundation and accessibility of facilitators **What:** Determine if facilitators can be assigned to Working Groups (p. 28) **Outcome:** Encourage co-learning, education on co-benefits	**What:** Provide equity training for Working Group members (p. 7; 58) **Outcome:** Prevents ideas incongruent with the concept of centering equity	**What:** Develop community training focused on equity and sustainability **Outcome:** Cultivates widespread community understanding of the importance of sustainability issues and centering equity **What:** Consider creating a cross-departmental equity group (p. 4; p. 35-36) **Outcome:** Will allow for further capacity building within the government and will further demonstrate the government's commitment to equity

Appendix G
Community Engagement and Outreach

Appendix G: Community Engagement & Outreach Process

Equitable engagement and communication is one of the seven cross-cutting community priorities that the Office of Sustainability seeks to uphold throughout the RVAgreen 2050 initiative.

Pre-Planning (2017-2019)

From 2017 through 2019, the Office of Sustainability built internal staff capacity, conducted research and technical modeling, participated in racial equity training, and gathered data to inform the rest of the planning process. During this time, the Office developed the RVAgreen 2050 Climate Equity Index, an innovative GIS based mapping tool that identifies the communities in Richmond that are on the frontlines of crises such as climate change. The Office is using the Index to purposefully reach out to those communities to engage them in the planning and implementation processes.

Understanding Community Priorities (2020)

A climate crisis, a global pandemic, and the legacy of white supremacy. These complex issues are challenging the health and safety of Richmond residents, livability of neighborhoods, and vitality of natural resources. In this phase of the RVAgreen 2050 planning process, we sought to ensure that the climate action and resilience plan addressed community priorities in an equitable way. We used an equity framework that included procedural, distributional, and structural equity.

The goal of this phase of the RVAgreen 2050 planning process was to listen to the community and gather information on successes, challenges, and everyday needs. Originally, listening sessions were designed around resident engagement. At the start of the COVID-19 pandemic, we adjusted our engagement plans based on the impact of the pandemic on residents and moved our focus to engaging organizations that work to empower communities on the frontlines of climate change. The organizations that participated in the community listening sessions focus on addressing community priorities such as empowerment, community investment, conservation, workforce development, and youth-based services. Additionally, to reduce redundancy, we found previous surveys and reports from other organizations to help identify and add context to the community priority list.

We acknowledge and understand that this was not direct feedback from residents. We used our best efforts given the existing circumstances to gather the main concerns and priorities to define the community priorities that would guide plan development. A community-wide survey followed this process to get feedback from the broader community. Finally, as we conducted our community listening process during the height of the COVID-19 pandemic and demonstrations across the city supporting the Black Lives Matter movement, we examined the relationship between crises such as climate change and COVID-19 and underlying inequities that cause disparate impacts which often come down to race.

The RVAgreen 2050 planning process identified actions and strategies that address the community priorities, help to achieve net zero greenhouse gas emissions by 2050, *and* help make our community more resilient to climate change.

In fall 2020, the Office of Sustainability convened community organizations serving frontline communities, institutional partners, government content experts, and other stakeholders for the RVAgreen 2050 Racial Equity & Environmental Justice Roundtable (as the central advisory group) and topical working groups: Buildings & Energy, Community, Environment, Transportation & Mobility, and Waste Reduction & Recovery. There were over 125 people involved in these key stakeholder groups.

To help monitor the Office's community engagement efforts, and based on the community listening sessions, staff also defined specific metrics to help guide the outreach.

1. Increase by 50% the total number of participants between each of the RVAgreen 2050 engagement periods.
2. Match citywide demographic representation within 10% across all engagement periods combined, and demonstrate an upward trend in achieving a representative sample of the Richmond population between each engagement period, within the following demographic categories: City Council District; age; race; ethnicity; education level; number of people in household; household income; and additional household factors (children, seniors, chronic health conditions, sensory impairment, mobility impairment).
3. Demonstrate an upward trend in the percentage of participants indicating that the mode of participation was easy to comprehend and complete between each engagement period.
4. Engage people who have never participated in a city planning process before, with a goal of 50% of participants across all engagement periods combined.

The Office of Sustainability committed to revisiting these goals during and in between each engagement period of the RVAgreen 2050 planning process to continuously improve outreach and communication efforts.

Plan Development (2021)

Starting in 2021, during the Plan Development Phase, the Office began working with these groups to translate the community priorities into strategies that achieve the following goals and ensure that the plan addresses the community priorities in an equitable way:

- Increase equity, particularly racial equity
- Reduce greenhouse gas emissions and pollution

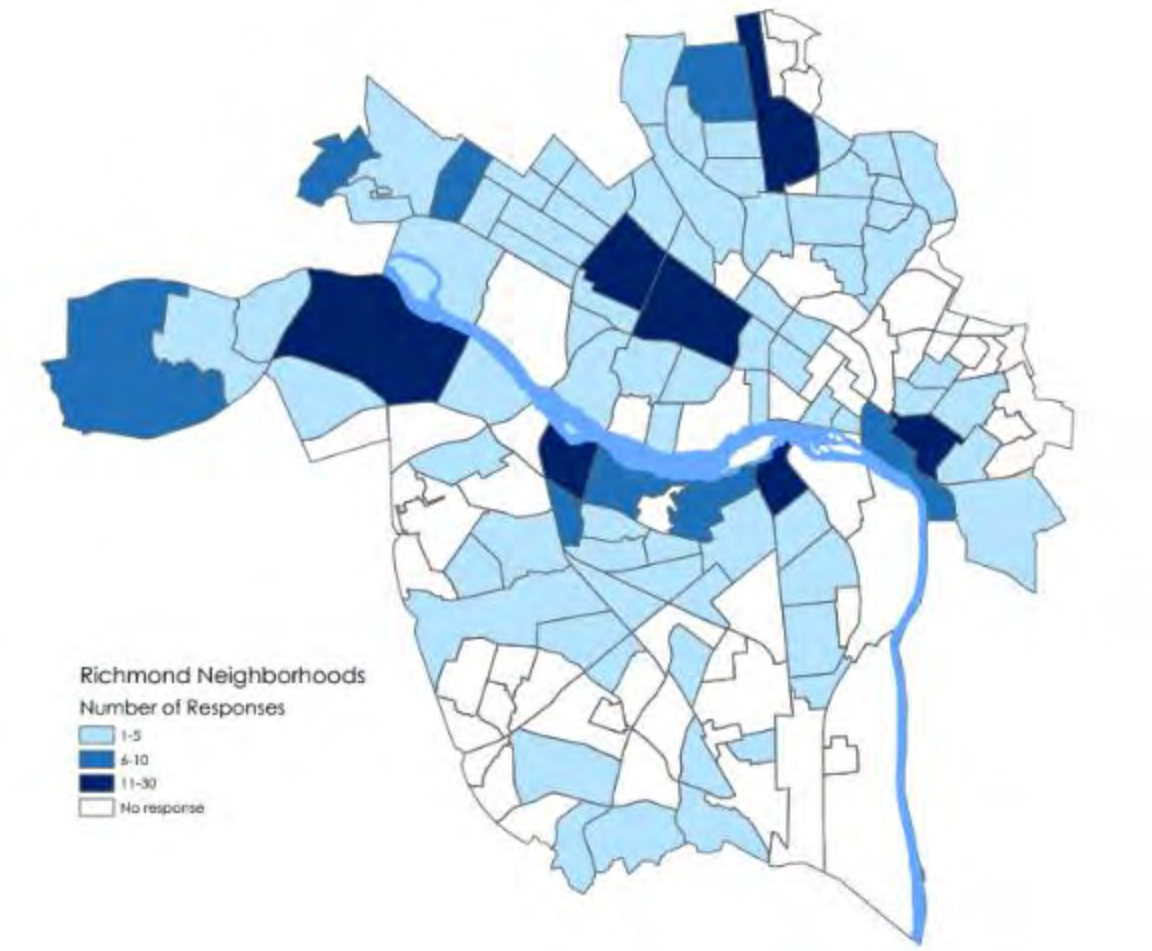
- Enhance resilience to climate impacts

In summer/fall of 2021, the draft strategies were refined based on community feedback.

The Office of Sustainability set ambitious engagement goals to drive our commitment to equitable and representative community participation in the RVAgreen 2050 planning process. The COVID-19 pandemic made engagement challenging throughout April 2021. Despite these challenges, the Office saw an increase in the number of participants from the 2020 baseline engagement period, and importantly, there was greater representation in this participation. The engagement in April reached a higher percentage of people of color and people from across income bands and educational levels.

The Office learned through its survey responses and conversations with Richmonders that the barrier to entry-level engagement with climate action planning was too high. This lesson helped staff better craft later engagement efforts to make RVAgreen 2050 a more accessible process in which every Richmonder is comfortable and motivated to participate.

Thinking about April 2021, Richmonders provided feedback on the RVAgreen 2050 draft vision, objectives, and strategies. Feedback was gathered in three different ways: through a 10- or 30-minute online survey, via direct commentary on a Konveio document of the draft plan, and by paper survey distributed by members of the Racial Equity and Environmental Justice Roundtable. The map below shows where these responses came from and helped inform future engagement efforts. Responses from all three sources of feedback were reviewed by Office of Sustainability staff and aggregated to inform progress towards our community engagement goals.



Adopt & Implement (2022 and beyond)

In Spring 2022, the draft plan was shared for community-wide input. This input informed how the Office of Sustainability finalized the plan ahead of seeking approval of the plan from City Administration, the Mayor, and City Council.

As part of our commitment to improved and more equitable engagement efforts, the Office of Sustainability is tracking progress in multiple ways as part of the RVAgreen 2050 Shared Accountability Framework. One of the tools we are using is the annual RVAgreen 2050 Community Sustainability Survey / Encuesta de Sostenibilidad Comunitaria, launched for the first time in spring 2022. The survey will be used to assess how the Richmond community is engaged and involved with climate action, resilience, and equity planning. It formalizes our commitment to listening to the community and continuous improvement to reflect the evolving needs and values of all Richmonders.

Communication and outreach strategies for RVAgreen 2050 are guided by the three core goals below to ensure that all Richmond residents are part of this ongoing engagement and community empowerment process.

Inform

Increase participation with RVAgreen 2050 by making it accessible, relatable, and meaningful to all Richmonders, regardless of race, ethnicity, personal identity, or neighborhood.

Engage

Grow and mobilize the network of informed and engaged advocates and implementation partners to help reach the RVAgreen 2050 goals.

Empower

Ensure community capacity to play an ongoing leadership role in creating pathways to direct impact toward an equitable, healthy, and resilient Richmond.

We commit to revisiting these goals during and in between each engagement period of the RVAgreen 2050 initiative to ensure these are meeting community priorities and continuously revise and improve our outreach and communication efforts.

Appendix H
Equity Screening Tool

City of Richmond
RVAgreen 2050

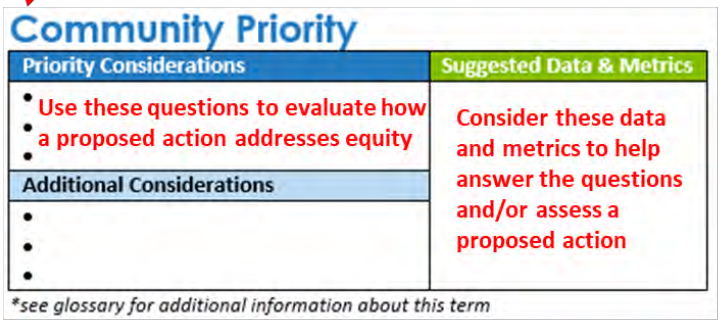
Equity Screening Tool

What is it? The RVAgreen 2050 Equity Screening Tool is designed to help determine the extent to which proposed climate action and resilience actions prioritize equity. It will be used to conduct a basic equity assessment of every action in the RVAgreen 2050 equitable climate action and resilience plan, as well as prior to making related decisions on policy, planning, programming, and budgeting.

How does it work? The Equity Screening Tool is organized by the seven community priorities gathered during the listening phase of the RVAgreen 2050 planning process. Stakeholders should review and answer the suggested questions in each community priority section to help recognize inequities, the conditions under which they thrive, and the possible solutions and environments that would mitigate negative effects and enhance positive results.

Note! The Equity Screening Tool requires ongoing evaluation and refinement to ensure effectiveness.

The tool is organized by the 7 community priorities gathered during the summer 2020 listening process



An asterisk (*) indicates that a concept or term is listed in the glossary at the end of the tool

Racial Equity and Environmental Justice

Priority Considerations	Suggested Data & Metrics
• Does this generate burdens*, either directly or indirectly, to historically disenfranchised communities*? • Does this acknowledge, respect, protect, and honor the culture, assets, and traditions of historically disenfranchised communities? • What communities would benefit* most from the proposed action?	• **What data tell you the answer to the question?** • Data disaggregated by race and ethnicity • Demographic information for those engaged in the process • Ongoing costs and to whom
Additional Considerations	
• Does this prioritize areas vulnerable to the impacts of climate change*? • What process was used to understand how the impacted communities feel about the proposed action? • Can the benefits be targeted in progressive/creative/proactive ways to reduce historical or current disparities?	

Engagement and Communication

Priority Considerations	Suggested Data & Metrics
• Does this engage and empower historically disenfranchised communities in a meaningful, authentic, and culturally appropriate manner? • How have communities (including historically disenfranchised) been engaged? • Does this help foster effective long-term relationships and trust between diverse communities and local government?	• **What data tell you the answer to the question?** • Demographic information for those engaged in the process • Frequency of and number of outlets for engagement • Number of partner organizations involved
Additional Considerations	
• Does this promote ongoing activities to update and involve the community? • Are there opportunities to expand engagement? • Does this align with and support historically disenfranchised communities' priorities, creating an opportunity to leverage resources and build collaborative partnerships?	

Government Accountability

Priority Considerations	Suggested Data & Metrics
• Has the community asked for this? Is there a mechanism in place to change the action as needed based on indicators and community feedback? • Is it clear who is accountable to whom and for what? • What is the current data related to the proposed action, where does it come from, and what does this data tell us?	• **What data tell you the answer to the question?** • Data disaggregated by race and ethnicity • *Evaluate the data source's potential bias*
Additional Considerations	
• Is the data disaggregated to show any potential disparity by demographics? • Is the action's metric or indicator meaningful to the community? • What accountability mechanism will ensure that historically disenfranchised communities will equitably benefit?	

Community Wealth

Priority Considerations	Suggested Data & Metrics
• Does this support historically disenfranchised communities through workforce development, contracting opportunities, or increased diversity of employees and staff across sectors? • Are the benefits accessible to households and businesses throughout the community - particularly communities of color, low-income populations, and minority, women, and emerging small businesses? • Will this create workforce training opportunities that offer living wages and support a product or service wanted and needed in the community?	• **What data tell you the answer to the question?** • Employer involvement • Workforce data disaggregated by race and ethnicity • Program participation • Geographic location of programs
Additional Considerations	
• Are workforce opportunities free of exclusionary restrictions? (e.g., criminal history, education, credit, etc.) • Could this increase opportunities for living wage jobs near where people live? • Does this distribute resources across the city?	

Affordable Housing

Priority Considerations	Suggested Data & Metrics
• Will this reduce the number of families that are cost-burdened by housing and transportation? • Does this reduce inequities in housing/building quality related to health and safety, such as issues related to lead, mold, air quality, etc.? • Could this increase access to housing in general, and to homeownership?	• **What data tell you the answer to the question?** • Housing and transportation cost burden disaggregated by geography, race, and ethnicity • Housing cost indicators (such as utilities)
Additional Considerations	
• What is the action's impact related to displacement of residents and small businesses? • Could this increase quality affordable housing stock across the city? • Does this promote access to resources in historically disenfranchised communities, such as quality schools and grocery stores?	

Neighborhoods

Priority Considerations	Suggested Data & Metrics
• Could this expand access to healthy, clean, and accessible transportation? • Could this increase access to quality green space in historically disenfranchised communities? • Could this increase and ensure long-term access to amenities* in historically disenfranchised communities?	• **What data tell you the answer to the question?** • Neighborhood-level engagement • Geographic distribution of resources • Non-vehicle transportation access
Additional Considerations	
• How does this address basic infrastructure needs that have not been met in the past? • How does this address historical and existing harm and inequity at the neighborhood level related to environmental hazards, racist policies, health hazards, and other issues? • Could this increase neighborhood-level initiatives such as markets, gardens, education, etc.?	

Health and Well-Being

Priority Considerations	Suggested Data & Metrics
• Does this address the health impacts of climate change*? • Could this reduce food insecurity? • Could this reduce stress, anxiety, and depression, and increase happiness?	• **What data tell you the answer to the question?** • Urban heat island • Health indicators (physical and mental)
Additional Considerations	
• Could this increase access to and quality of health services? • Does this address historic and existing health hazards? • Could this increase safety and security* in the community? (Does this address the external factors influencing crime such as trauma, poverty, housing, education, and physical and mental health?)	

Appendix I
Detailed Methodologies for Plan Content Development

Appendix I: Detailed Methodologies for Plan Content Development

Strategy Prioritization Methodology

In early 2021, the Technical Working Groups identified 188 unique draft strategies to equitably achieve net-zero greenhouse gas emissions and climate resiliency by 2050. However, to ensure that the Plan is both ambitious in terms of equity, climate action and resilience and achievable given timelines, available resources, and capacity the working groups prioritized the strategies down to 49 across the five RVAgreen 2050 pathways. After discussing a variety of statistical methods with Dr. Jeremy Hoffman of the VA Science Museum, the Office of Sustainability developed an innovative methodology – the Prioritization Matrix – to accomplish this very complex and difficult task.

To compare the 188 draft strategies, the Office developed a scoring system for the criteria between 1 (low impact) -5 (high impact) based on their potential impact on greenhouse gas emissions reductions, improving resilience to climate impacts, and elevating the 7 community priorities to answer the question "To what degree would the strategy address or improve each of these criteria?". These ratings were shared during the community engagement period during the spring of 2021 so that community members could better assess the potential impacts of the strategies against each other.

In addition to ratings associated with greenhouse gas emissions, resilience, and community priorities, it became obvious that additional considerations should be evaluated in order to ensure that the strategies met the 'SMARTIE' criteria.

Strategic?	*…reflects an important dimension of what your organization seeks to accomplish (programmatic or capacity-building priorities)*	***Cost-effectiveness Economic Development***
Measurable?	*…includes standards by which reasonable people can agree on whether the goal has been met (by numbers or defined qualities)*	*GHG / Resilience Goals*
Ambitious?	*…challenging enough that achievement would mean significant progress; a "stretch" for the organization.*	*GHG / Resilience Goals*
Realistic?	*…not so challenging as to indicate lack of thought about resources or execution; possible to track and worth the time and energy to do so*	***Feasibility***
Time-bound?	*…includes a clear deadline*	*GHG / Resilience Goals*
Inclusive?	*…brings traditionally excluded individuals and/or groups into processes, activities, and decision/policy making in a way that shares power*	***Community Support***
Equitable?	*…includes an element of fairness or justice that seeks to address systemic injustice, inequity, or oppression*	*Community Priorities*

In total, the Office formulated 13 unique criteria - 6 that comprised the "Impact Score" and 7 that comprised the "Equity Score". Criteria were weighted according to their importance in determining the priorities needed to reach the goals of the Plan and to ensure that the prioritization scoring reflected equity-centered values appropriately. The task of weighing the criteria against each other to inform the values of the Plan was left to the Racial Equity & Environmental Justice Roundtable. Upon review, the Roundtable agreed on the two separate categories (i.e. Impact Score and Equity Score) of scoring having equal weight - but believed that some of the criteria within each category should be weighted more heavily than others.

(1) **Impact Score Criteria**: Attributes relevant to climate resilience, carbon footprint, implementation constraints (i.e. feasibility, cost-effectiveness, economic development), and a ranking of community support.

Impact Score Criteria	Weight	Description
GHG	x8	The amount of greenhouse gas emissions reduced by this strategy or action (*see notes below)
Resilience:	x4	The improved resilience to climate impacts by this strategy or action (Note: 'Resilience Score = the average of the 4 climate impact scores below)
· *Heat*		The improved resilience to heat by this strategy or action
· *Extreme Weather*		The improved resilience to extreme weather by this strategy of action
· *Flood / Sea Level Rise*		The improved resilience to flooding and/or sea level reside by this strategy or action
·*Community Resilience*		The improved community (i.e. 'people-centered') resilience to climate impacts by this strategy or action
Feasibility	x4	The ease of overcoming barriers and acquiring necessary financial and political capital required
Cost-Effectiveness	x4	The cost of implementation versus the rate of return
Community Support	x4	Priority rankings of strategies from the Spring 2021 Community Engagement 30 minute survey
Economic Development	x2	The number of jobs created and sustained as a result this strategy or action

(2) **Equity Score Criteria**: Each of the community priorities identified through the community listening sessions.

Equity Score Criteria	Weight
Racial Equity & Environmental Justice	**x6**
Health & Well-Being	**x5**
Government Accountability	**x3**
Community Wealth	**x3**
Housing & Buildings	**x3**
Neighborhoods	**x3**
Engagement & Communications	**x3**

EXPLANATION OF CRITERIA SCORING

GHG Score	Impact Score (Greenlink)	GHG reductions potentials (tonnes CO2e) (Integral)
1=low	impact = 1	<3,000
3=medium	impact = 2/3	3,000 to 96,000
5=high	impact = 4/5	>96,000

Feasibility Score (Greenlink):
1 Extremely high barriers and amounts of financial and political capital required
2 Somewhat high barriers and high amounts of financial and political capital required
3 Moderate barriers and amounts of financial and political capital required
4 Slight barriers and mild amounts of financial and political capital required
5 Low barriers and amounts of financial and political capital required

Cost-Effectiveness Score (Greenlink):
1 High upfront cost with a slow return on investment
2 Somewhat high upfront cost and slow return on investment
3 Typical costs and return on investment
4 Better than average costs and return on investment
5 Low upfront cost and an excellent return on investment

Community Support Score (Office of Sustainability):
During the Spring 2021 engagement period, community members completed surveys ranking the strategies that they believed would be most important to them on a scale from 1-5 with 1 being the least important and 5 being the most important. The response scores were averaged for each strategy:
1 low community support
2 low-medium community support
3 medium community support
4 medium-high community support
5 high community support

Economic Development (Greenlink):
1 Less than 10 jobs created/sustained
2 10 - 50 jobs created/sustained
3 50 - 100 jobs created/sustained
4 100-500 jobs created/sustained
5 500+ jobs created/sustained

Equity Criteria Scores (Office of Sustainability and Racial Equity & Environmental Justice Roundtable):
On a scale from 1-5 with 1 being the lowest and 5 being the highest, the strategies and actions were ranked according to their potential impact on addressing each of the 7 community priorities:
1 low potential to improve this community priority
2 low-medium potential to improve this community priority
3 medium potential to improve this community priority
4 medium-high potential to improve this community priority
5 high potential to improve this community priority

PRIORITIZATION MATRIX TOOL

For each of the 188 draft strategies, the Office multiplied the unique weighting for each of the 13 criteria by the pre-tallied score for each strategy. Once all of the weighted scores were calculated they were summed to arrive at a weighted Impact Score and a weighted Equity Score for each strategy. Below is an example of the matrix tool for a number of strategies:

Pathway	Obj	Strategy	GHG Notes	Heat	Extr. Wthr	Flood Sea Level Rise	Community Resilience	Resilience	GHG	Feasibility	Cost ffectiveness	Economic levelopment	Community Support	WEIGHTED COMBINED	Racial Equity / Environmental Justice	Health & Well-Being	Govt ccountability	Community Wealth	Housing & Buildings	ighbor-hoods	ngagement &	WEIGHTED COMBINED UITY SCORE	% COMBINED SCORE
T&M	2	**Bus Service** - Improve public transit frequency, reliability, access, convenience, user	210k or 6.66% impact 5	1	1	1	1	1	5	3	4	2	4	92	3	1	1	5	3	3	1	62	100%
B&E	3	**Solar Installations:** Provide financial assistance and education for clean energy upgrades and retrofits to make	470k or 14.31%	1	3	1	1	1.5	5	4	4	2	3	94	3	1	3	1	5	1	1	56	99%
Env	3	**Neighborhood Prioritization** - Use community input and data (such as the Climate Equity Index, RVA311, RVAH2O, and other sources) to		3	3	3	3	3	1	5	3	1	4	70	3	3	5	1	1	3	5	78	99%
B&E	2	**Energy Efficiency Assistance:** Aid households that have the highest energy burden with	685k	1	3	1	1	1.5	5	3	4	3	4	96	3	1	1	1	5	1	1	50	97%
T&M	2	**Bus Stops** - Improve and maintain priority transit stops in low-income and	270k or 8.57%	3	3	1	1	2	5	3	4	2	4	96	3	1	1	1	1	5	1	50	97%
Env	2	**Urban Heat Islands** - Develop an urban heat island readiness and reduction plan with a focus on vulnerable populations and ecosystems. Include		5	3	1	3	3	1	4	3	2	5	72	3	3	1	1	3	5	3	72	96%
B&E	3	**Ground-Mounted Solar:** Incentivize opportunities for local ground-mounted solar and	470k or 14.31%	1	3	1	3	2	5	4	3	3	4	98	3	1	1	1	3	1	1	44	95%
Env	1	**Community Gardening** Develop - and make visible and accessible - an urban agriculture program that partners with food justice community organizations and includes an apprenticeship training program. Identify changes		1	1	1	3	1.5	3	4	4	3	5	88	1	3	1	3	1	3	3	54	95%
B&E	2	**Electrification:** Promote the benefits of electric-only commercial	575k or 28.87%	1	1	1	1	1	5	5	3	1	1	82	3	1	3	3	3	1	1	56	94%
Comm	1	**Community Benefit Agreements** - Develop community benefit agreements with target community members, which could include items such as		1	1	1	3	1.5	1	4	4	3	3	64	3	1	3	5	3	3	3	74	94%
Env	3	**Green Infrastructure Master Plan** - Implement the Green Infrastructure Master Plan		3	5	5	3	4	1	4	3	2	5	76	1	3	1	1	1	5	5	60	91%

The final step of this process was to determine how to limit the number of strategies so the Plan could be both ambitious and successful. The Office ran multiple scenarios:

1) Sort all 188 draft strategies according to *Impact Score* and then identify those that fell in the top 75th percentile.
2) Sort all 188 draft strategies according to *Equity Score* and then identify those that fell in the top 75th percentile.
3) Sort all 188 draft strategies and only select those that identified within the top 75th percentile for *both their Impact Score and Equity Score*.

4) Sort all 188 draft strategies by their *combined Impact Score and Equity Score*, focusing on those that fell into the top 75th percentile.

1	Sort by IMPACT score, informed by equity	✗		• Looked like a traditional climate action plan • Resilience is not prioritized • Equity is not centered
2	Sort by EQUITY score, informed by impact	✗		• Looked like a resilience plan • Mitigation is not prioritized
3	Top IMPACT and EQUITY only	✗		• Too limiting; number of strategies would make it difficult to achieve our 2030 goals
4	Sort by combined IMPACT + EQUITY scores		✓	• "Not too hot, not too cold, just right" • Isolate strategies in the top 75th percentile based on combined scores

The fourth option turned out to be the *'Goldilocks Scenario'* and generated a shorter list of prioritized strategies that would allow us to achieve our 2030 goals to reduce greenhouse gas emissions by 45% *and* prepare Richmond for climate resilience while centering equity. All stakeholders were in agreement that the methodology used for this final scenario ensured that the individual weights of the criteria led to appropriate prioritization. In the end, the Impact Score and Equity Score when combined resulted in a final score for each strategy that could be ranked so that we could prioritize those that fell in the top 75th percentile.

Each Working Group then reviewed the strategies in the 4th scenario that were relevant to their group. Based on their feedback, two things became apparent:

1) The scope of the strategies varied. Some were more holistic and some were very specific.

2) Some of the strategies that did not rise to the top 75th percentile were still important to the overarching goals of the Plan.

To address these two points of feedback, many of the more specific strategies that were important to the goals of the plan were listed under broader strategies as "actions" while others were either combined or removed altogether. Ultimately we arrived at the collective list of 49 prioritized strategies contained in the 2030 Climate Equity Action Plan. In order to further guide prioritization of the strategies for implementation, the actions within each strategy with a timeline of 2022-2026 should inform that the respective strategy be moved to the top of the list and then further ranked according to their combined weighted score.

	Impact	Feasibility	Cost-Effectiveness	Economic Development
1	Very low	Extremely high barriers and amounts of financial and political capital required	High Cost/Slow Return on investment	Less than 10 jobs created/sustained
2	Low	Somewhat high barriers and high amounts of financial and political capital required	Somewhat high cost/slow return on investment	10 - 50 jobs created/sustained
3	Moderate	Moderate barriers and amounts of financial and political capital required	Typical costs and return on investment	50 - 100 jobs created/sustained
4	High	Slight barriers and mild amounts of financial and political capital required	Better than average costs and return on investment	100-500 jobs created/sustained
5	Very high	Low barriers and amounts of financial and political capital required	Low cost/Excellent Return on investment	500+ jobs created/sustained

Weighting was assigned to each criterion as follows:

IMPACT SCORE		
GHG	The amount of GHG emissions reductions	x8
Resilience	Improved resilience to climate change impacts	x4
Feasibility	Barriers and amounts of financial and political capital required	x4
Cost-Effectiveness	The cost of implementation vs. the rate of return	x4
Community Support	Priority rankings from the 30 min survey	x4
Economic Development	The number of jobs created and sustained	x2
6 Criteria		26 Total

EQUITY SCORE	
Racial Equity/Env. Justice	x6
Health and Wellbeing	x5
Gov. Accountability	x3
Community Wealth	x3
Housing and Buildings	x3
Neighborhoods	x3
Engagement and Communications	x3
7 Criteria	26 Total

Outcomes & Indicators Development Methodology

A reoccurring question throughout the Plan development process was "What metrics are we going to track in order to ensure that the plan is successful?". While it is possible to identify hundreds of data sets that could be tracked all the way down to the action level, it is most important that the 'SMARTIE Model' is revisited reminding us of the expectations are measurable, ambitious, and also realistic (i.e. not so challenging as to indicate lack of thought about resources or execution possible to track and worth the time and energy to do so).

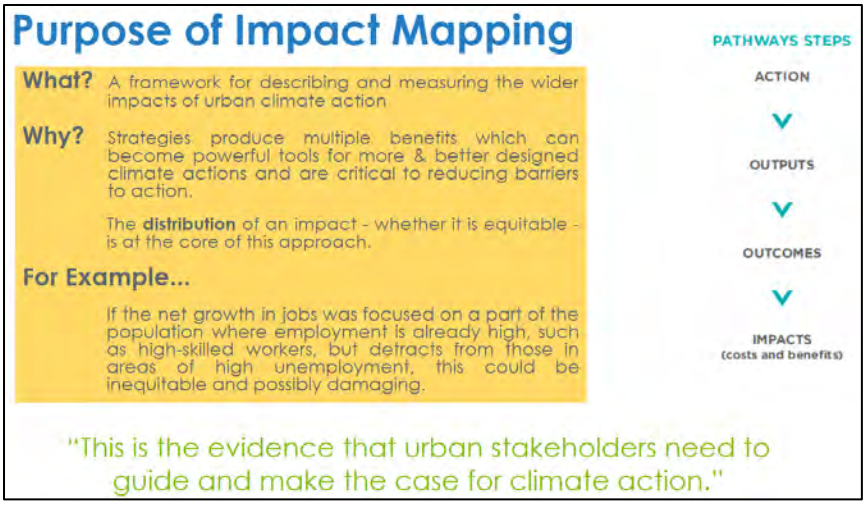
A collaborative initiative led by C40 Cities Climate Leadership Group developed the 'Urban Climate Action Impacts Framework: A Framework for Describing and Measuring the Wider Impacts of Urban Climate Action" to help cities explore the wider impacts of city climate action. This tool was reviewed by the Office of Sustainability and shared with the technical working groups to serve as a tool for identifying the measurements that would rise to the top in order to serve as a holistic indicator of successful implementation of the strategies.

> Impacts: How will our strategies impact the community and lead to a more equitable, resilient, and adaptive Richmond?
>
> Indicators: How will we measure success?

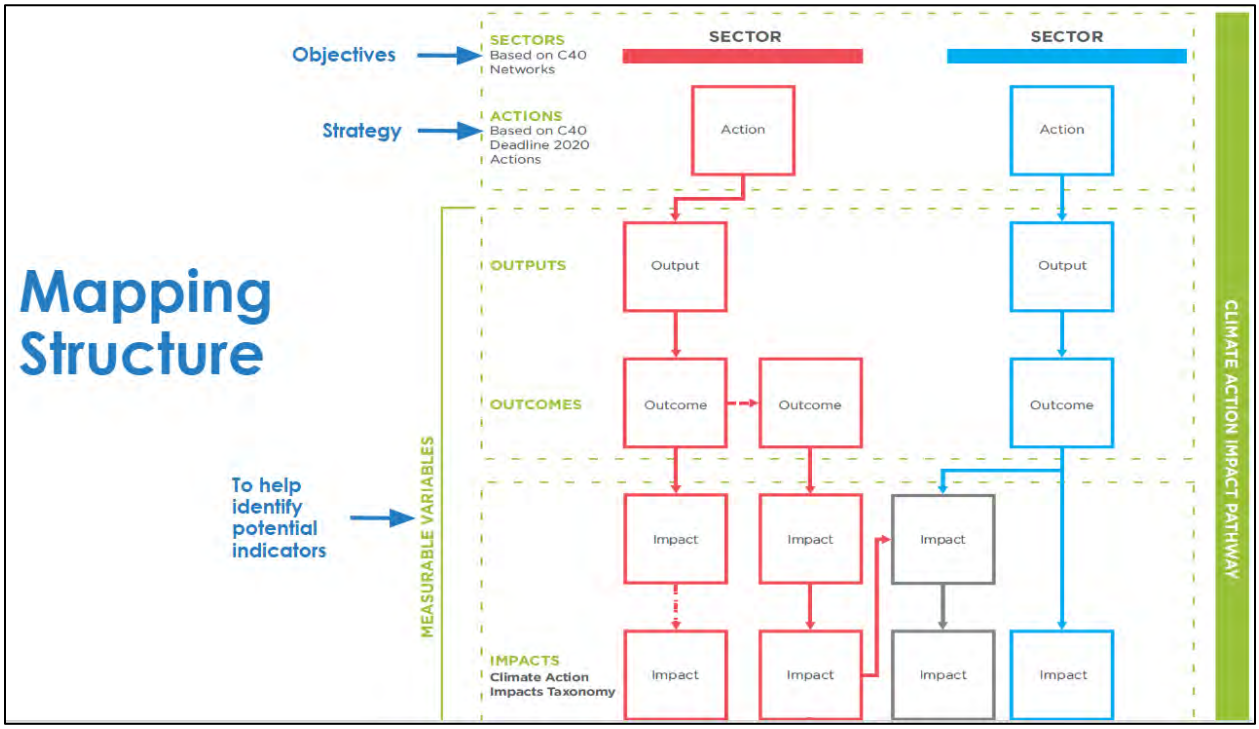
Impact Mapping Exercise

Working group members were asked several questions:

- What are the potential impacts of our strategies?
- What are we trying to impact?
- What does success look like for each strategy and what is our shared understanding of what is achievable?
- How can those impacts inform the indicators that we use to measure success?

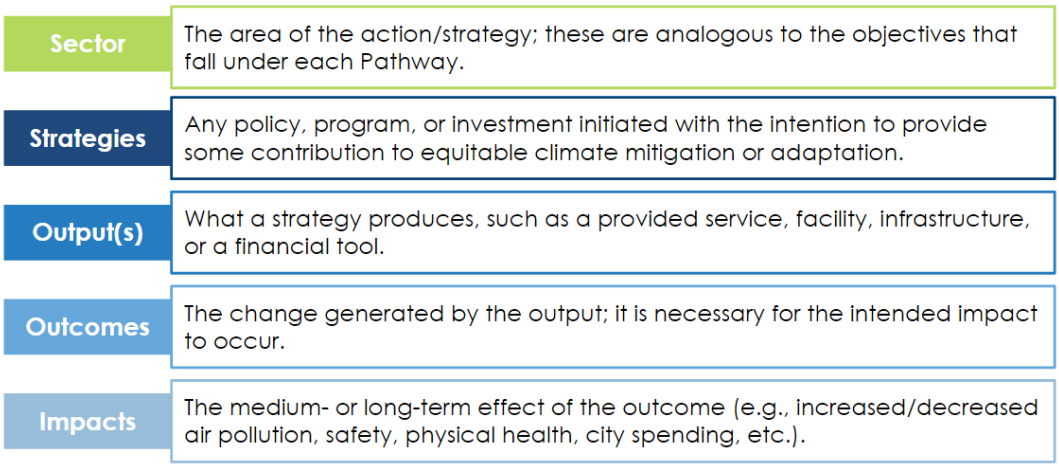


The Outputs and Outcomes are the intermediary steps and inter-relations between the strategies and the impacts that need to be identified in order to fully understand the actionable elements of each strategy.



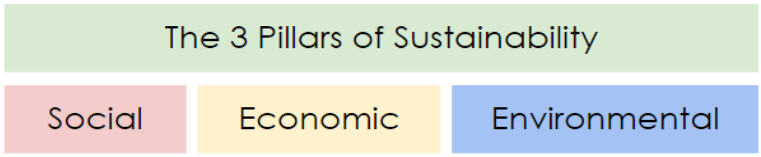
The exercise of defining each step as part of the impact mapping for each strategy was challenging and required working group members to continually refer back to the definitions for consistency.

Structure of impact maps



In order to center equity in the exercise of impact mapping, working group members were asked to identify impacts that connect the strategies back to the community priorities by focusing on the ones most relevant to our planning process and community priorities. This systemic perspective was very helpful because city life is highly interconnected due to the fact that the environment, society and the economy all impact each other in complex dynamics.

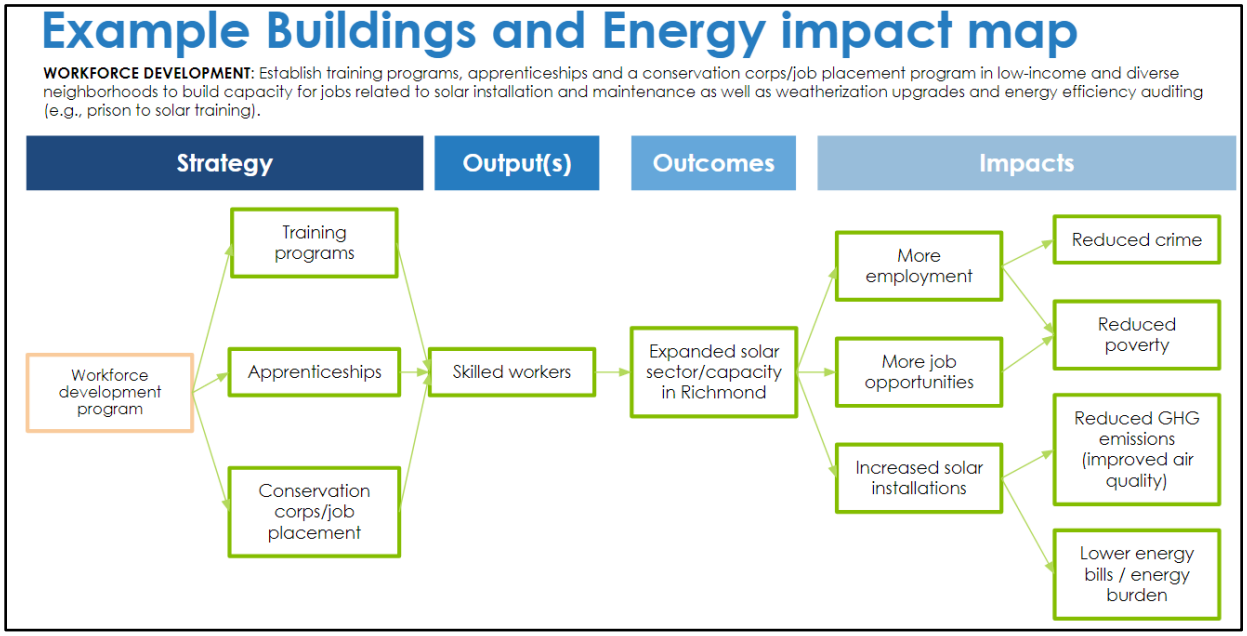
Types of impacts



Racial Equity & Environmental Justice: *Potential to promote racial equity and support historically disenfranchised communities*
Government Accountability: *Potential to promote government accountability and transparency*
Community Wealth: *Potential to build community wealth and increase jobs and education access*
Housing & Buildings: *Potential to expand affordable housing and reduce housing cost burden*
Neighborhoods: *Potential to support beautiful and safe neighborhoods*
Health: *Potential to promote physical and mental health and well-being*
Engagement & Communications: *Potential to support equitable engagement and communication*

For example,

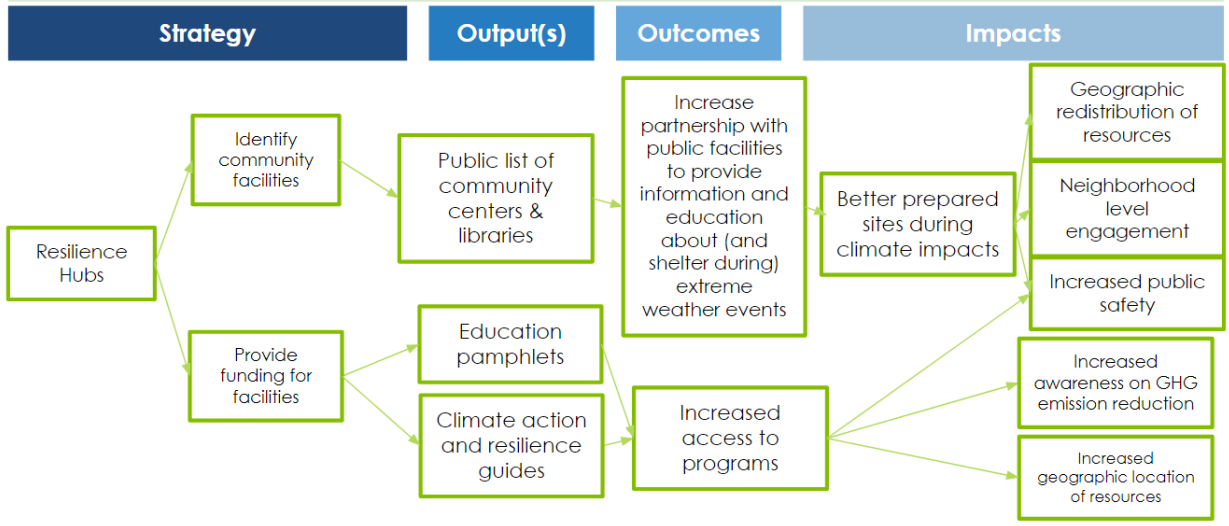
- People's health and prosperity are intimately dependent on environmental management and biodiversity.
- Safety and fairness of jobs enhances physical and mental health.
- Government accountability and community engagement improve all aspects of city life from community-scale projects that enhance neighborhood livability to the better design and monitoring of policy.
- The aesthetic quality and cultural heritage of Richmond are drivers of tourism and economic prosperity.
- Improved equality is directly related to trust, civic participation, social cohesion and ultimately sustainability.



Example Community impact map

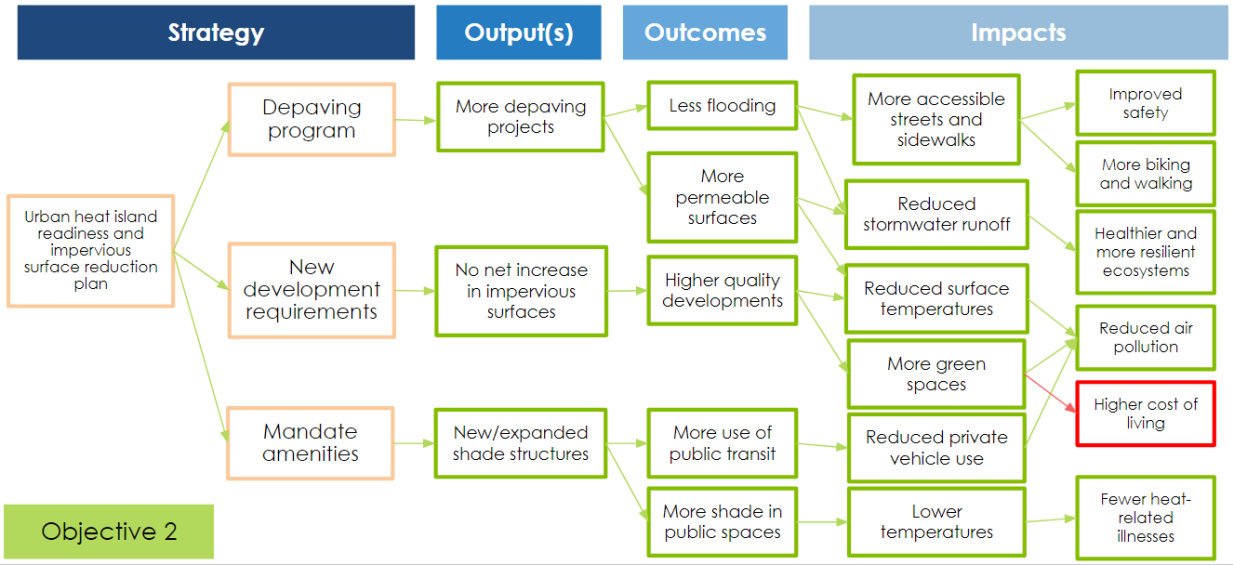
Objective 2: Increase the Richmond community's social resilience to climate change.

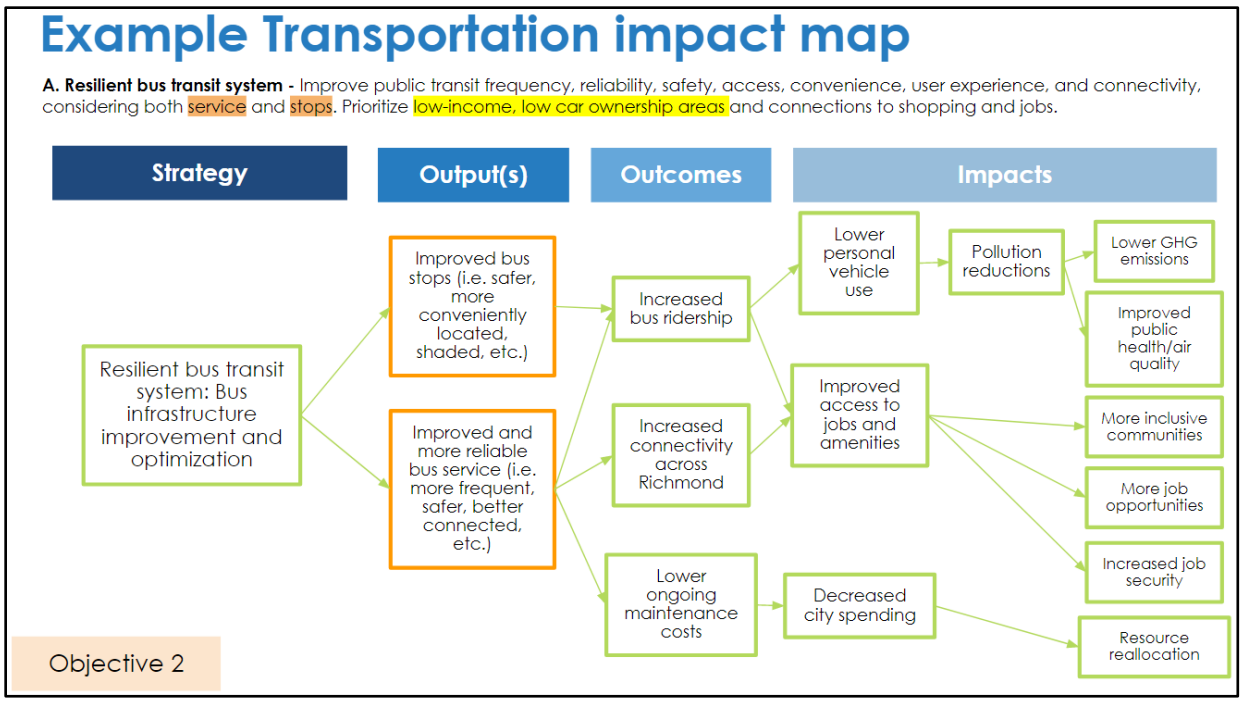
Strategy: Resilience Hubs - Identify community facilities across the city, such as community centers and libraries, and provide funding to enable these resources to serve as resilience hubs and cooling centers to the community, particularly in areas with low-income, elderly, young, and homeless populations

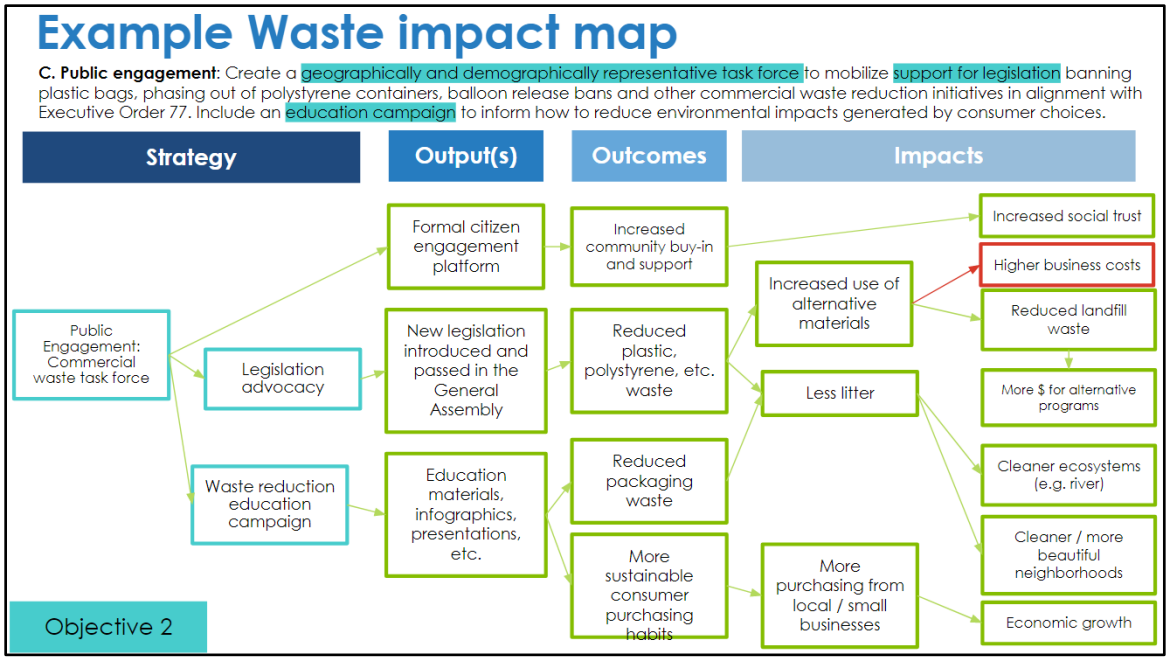


Example Environment impact map

IMPERVIOUS SURFACE MANAGEMENT: Develop, fund, and implement an ***urban heat island readiness and impervious surface reduction plan*** with a ***focus on vulnerable populations and ecosystems***. Include tactics such as ***mandating benches and shade structures*** at all bus stops and establishing "rubber-stamped" shade structure designs that businesses can build and install in the public right-of-way. Develop a ***depaving program*** *plan for impervious surfaces* that includes an *ordinance* to allow non-DPW entities to conduct *depaving projects*, with standards and guidelines for such projects. Establish ***requirements for major development*** related to mandating no net increase in impervious surface areas upon project completion.







Working group members spent considerable time on each strategy in order to identify outputs and outcomes and concentrate on impacts (both positive and negative). For each strategy, the working groups were asked to first consider scale and scope, as well as the business as usual scenario (i.e. What would it look like if the strategy was not implemented?) in order to adequately frame the conversation followed by:

1. What are the outputs of this strategy? (i.e. what are the direct, tangible results of the strategy?)
2. What are the outcomes of this strategy? (i.e. what is the change generated by the output?)
3. What are the potential impacts that could result from this strategy by integrating equity considerations?
4. Who the key stakeholders are? What are their priorities and concerns? How is the strategy potentially impacting them – positively or negatively?
5. Which impacts are most significant?

Outcomes Selection

Once all of the impact maps were completed they were compiled in order to identify the overlapping impacts that were repeated across strategies, objectives, and pathways.

tons landfill waste	# of mitigation projects	# of Energy Star buildings	Building EUI	VMT	people using micromobility	# of transit ridership	parking lots
gas powered vehicles	green space	air quality	soil quality	hazardous spills	water quality	# of resilience / maintenance projects	heat islands
fiscal health / economy	loss of tax revenue	ROI of projects	gov't accountability & efficiency	climate action funding	jobs	equitable development	community wealth
# of businesses & residents	beautification	noise pollution	public safety (also traffic related injuries & fatalities)	climate education	community cohesiveness		
civic engagement	community engagement	community health and well-being	# climate related illnesses & fatalities	energy burden	housing		

The impacts were then sifted into potential metrics by the working groups:

tons of landfill waste	Clean & Efficient Buildings: Infrastructure Efficiency Improvements: # of energy projects (e.g. rooftop solar installations, weatherization projects, EE retrofits, # of Energy Star buildings, EUI, etc...)		Zero pollution from transportation: Transportation Mode Shift (away from single occupancy ICE vehicles): VMT/PP, active transportation/mode share (i.e. people using micromobility, transit ridership, # of parking lots, % of EV vs ICE)	tree canopy cover, distance to green space
air quality index	water quality monitoring	# of resilience projects (needs to be defined)	# of partnerships / # of grants vs budgeted city $	time of year
Distance to green space	unemployment, % of living wage jobs, # of green jobs	# climate related illnesses & fatalities	avg energy burden, % of households with high energy burden	what are our engagement goals?

When the impacts and potential metrics were organized by community priority it became apparent that there were overarching themes that the community wanted to see:

Emissions from waste	Emissions from buildings	Emissions from Transportation	Green Space	Improved Air Quality	Improved Water Quality	Resilient Infrastructure
lower temp diff between hottest & coolest areas of the city; lower avg temps across entire city		Climate Action Funding	Community Wealth (Workforce Development)	Outreach & Engagement	Community Health	Energy Burden

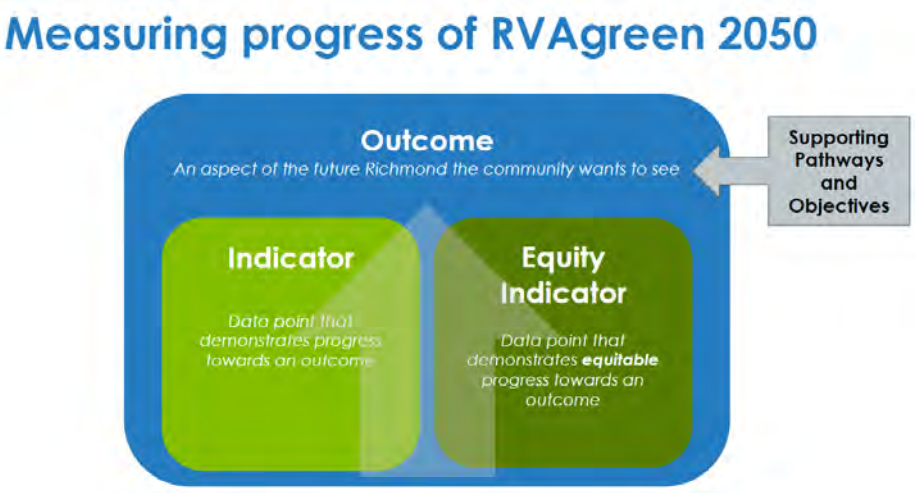
...And from here the 12 overarching outcomes were developed to describe the achievements that Richmonders will realize by implementing the Climate Equity Action Plan as a whole:

PATHWAY	OBJECTIVE	Cleaner and more efficient buildings	Engaged and involved community	Improved air quality	Advanced green economy	Increased support for climate action	More green space and trees	Lower GHG emissions	Increased heat resilience	Increased flood resilience	Climate-ready community	Less landfill waste	Cleaner and more efficient transportation
Buildings & Energy	1	x	x	x	x	x		x	x	x	x		
	2	x	x	x	x	x		x		x	x		
	3	x	x	x	x	x		x	x	x	x		
	4	x	x	x	x	x		x		x	x		
Comm-unity	1	x	x	x	x	x		x		x	x		x
	2	x	x		x	x				x	x		
Environ-ment	1		x	x	x	x	x	x	x	x	x		
	2			x	x	x	x	x	x	x	x		
	3		x	x	x	x	x	x	x	x	x		
	4	x		x	x	x	x	x	x	x			
Trans-portation	1		x	x	x	x	x	x	x	x	x		x
	2		x	x	x	x	x	x	x		x		x
	3		x	x	x	x		x			x		x
Waste	1		x	x	x	x		x			x	x	
	2		x	x	x	x		x			x	x	
	3		x	x	x	x	x	x			x	x	
	4		x	x	x	x		x		x	x	x	

Indicators Selection

The next challenge was to determine how to track and monitor whether or not the implementation of the strategies in the Plan are successfully meeting the community's needs. To measure progress, it was determined that each outcome would have one traditional indicator and one equity indicator. This combination will

help us to ensure that we are making progress that is resilient, will lower GHGs, and will also help to achieve an equitable outcome. As noted in the chart above, each outcome is supported by multiple pathways and objectives and strategies.



Working groups were asked to brainstorm a 'data wish-list' for each of the outcomes to ensure that all elements of potential indicators were considered:

Advanced green economy	
Indicators	# businesses participating/undertaking green practices; # of graduates from Goodwill job training, sustainable certificate programs, etc. What are "green" programs (e.g., solar panel installers, rain gardens, sustainable agriculture)?
Equity Indicators	# programs for training, education, apprenticeships, etc. related to climate action, resilience and green jobs; # of businesses owned by BIPOC, women, etc. that participate in green practices
Considerations	~Define green economy ~Track % of energy used that is generated locally. Track % of food consumed that is produced locally. Track hiring by firms in green industries or in greening part of an industry. Track commuting miles and VMT. Track energy intensity of industry sectors and compare to national averages. Track # employers offering bus passes, lockers/showers for bikers, teleworking, green space and access to outdoors, sustainable purchasing policies, use of electric vehicles, etc. ~Define what jobs qualify as green and use the existing tracking (QCEW Bureau of Labor & Statistics) ~Look at 3rd party certifications for 'green economy'...procurement? Food? Waste? Define these categories along the supply chain / sectors (e.g. # of certified B corps) ~Measure economic benefits of a greener/sustainable business practices (ROI could be the indicator) ~Match the numbers to the 'story' and the people and the mission and the reason that people are coming to Richmond to promote economic development and the long-term recruiting/retention of residents ~Tech zone (Ord 2019-275) / metric of how many people are involved toward green economy / econ development; Define green practices / what are the benchmarks? ~Waste diversion, energy efficiency, fuel sources, etc.? ~Verified Best Management Practices ~"Certified Green ___" businesses - need an auditor to verify - what are the standards? ~New questions in business permitting about green economy / green practices --- this becomes city data ~How to protect against green gentrification as businesses implement green practices? How to support black-owned businesses that want to be green? ~Incentives vs. penalties for green practices and how NOT to disproportionally affect SWaM businesses

	~Volunteers who need apprenticeship or community service hours as data collectors; Include government agencies like GRTC and other city departments (programs should be green & supports green economy). ~# of people and the demographics of the people that are going through these established programs, also where are these people from (what neighborhood?) ~City budget - amount allocated to programs like this but also more general towards green economy; something re business attraction? ~Virginia Conservation Network job board metrics? ~Not just jobs but also helping to create new businesses - green and equitable ~RPS curriculum re environmental justice (education - not just adults) - like required economics and personal finance course for HS, also look at younger grades ~Professional development for teachers and faculty - certifications ~VA Green jobs tax credit (FOIA from the Treasury) by census tract? ~Capture demographics of participants enrolled in the training and/or jobs ~# of apprenticeships and training events (IBEW Chapter 666 local Richmond/Sandston)
Cleaner and more efficient transportation	
Indicators	Increased mode shift away from single occupancy internal combustion engine vehicles % travel that is not w/ a SO-ICE-V"
Equity Indicators	% of living wage jobs accessible within [X commute time-45 min] via FIXED ROUTE public transit w/in city? Can we restrict to a little outside city limits to capture more people who cross for commute, etc. % of labor force w/in 10 min walk of transit? + safe walk, ADA accessible, sidewalk quality % of people within a 10-minute walk of a FIXED ROUTE transit stop with amenities (cover, bench), disaggregated by neighborhood, race, and income - could also disaggregated by vehicle access, health factors, age of transit riders
Considerations	~Track changes over time of bus stops with amenities - GRTC working on increasing from 5% of stops to 50% over the next 5 years; starting in under-resourced communities ~Commute times go beyond Richmond city lines, involves surrounding localities/counties; look at what type of jobs (white collar vs. blue collar, frontline essential, etc.) ~Is 10-minute walk ADA accessible - sidewalks free of impediments, etc. ~Consider fixed-route 10 minute distance, vice services like the Care Van (on demand, door-to-door)
Climate-ready community	
Indicators	# and reach of services and initiatives integrating information on climate change impacts and readiness Emergency response systems/depts/resources that are climate ready (incl food, fuel, ice) Power outages - by neighborhood
Equity Indicators	% population facing "high vulnerability" to climate change via the RVAgreen 2050 Climate Equity Index; Access to cooling shelters within X distance [under “normal” circumstances] Access to climate-ready shelters by neighborhood <- equitable distribution and access to these resources

Considerations	~A key piece of social resilience is an individual's own network (like a relative they can go to for help) - but may not be able to measure this ~Mutual aid agreements w/ other municipalities (possibly look at regional hazard mitigation plan) ~Widespread distributed generation resources are key - ideally that generation is clean energy ~Super-efficient buildings are more disaster ready: "passive survivability"; Communicate health impacts and the importance of climate initiatives as it relates to health ~Service based measurement: (e.g. # of people taking advantage of cooling centers, # of churches giving fans, # of people displaced by climate impacts ~Is this something that will be consistently monitored (can this be done every year) ~There should be some form of pre/post survey to assess climate readiness ~Need to define: What does a climate-ready community look like? ~Education - # students taking a class on topics for awareness ~Access to resources to be resilient - where the information is being distributed ~Define the 'resilient initiatives' and then measure the total # of participants both community-based and city-based, measure the # of initiatives, and then agree on deliverables (e.g. event, specific goals) but have an ongoing feedback loop for continual back and forth (i.e. participation and utilization rate per initiative and compare on an ongoing basis) ~Measure diverse perspectives and measure each (i.e. types of organizations/communities that participate) ~Disaggregate by type of housing, income, geography, race and create a cross-section of who is involved ~Data capture: brief survey (4-5 questions) online and/or during event ~Capture number of participants and successful strategies across the board with metrics that would add up ~Use social media metrics as one way to measure ~I believe in the saying "show them better than you can tell them" - outreach showcase initiatives where community engagement and participation is encouraged and recognized as collaborative efforts. ~Individuals do not always have the ability to react to weather impacts - how do we empower vulnerable individuals to survive threats? ~Less about communication, more about empowerment ~Think about ways to make this more about what the community can actually use beyond information - access to resources like cooling, recourses like workplace safety laws?
Engaged and involved community	
Indicators	Total participation in climate action and resilience initiatives (to be defined) - compare city-based and community-based initiatives participation
Equity Indicators	Demographics of participation (goal is to match citywide demographics) - compare city-based and community-based initiatives participation Usage of Equity Screening Tool and Climate Equity Index

Considerations	~Participation/engagement is different from taking action is different from results (3 levels of engagement that would need to be measured and need to be reviewed for 'who' and which parts of the population) ~Align with Mayor's ambassadors (Office of Public Information & Engagement) to ensure that the information is going to more than the 'usual suspects' ~Look to current successful engagement outlets (e.g. neighborhoods, PTAs, farmers markets, etc.) ~Engagement during the planning process is the 'ask'...engagement during the implementation phase is the 'sell/promotion' of strategies. If we could disaggregate demographically and model by potential/expected cost savings by neighborhood it could ensure equitable ~Engagement/implementation of strategies; Track number of forms of engagement, consistently use multiple options (virtual, in-person, one-on-one community listening) ; tag events w/ rvagreen so we could get data easily ~Survey? Quick, 2-3 questions, easy to take (postage paid for paper surveys) ~"Take this quick survey if you are engaged in..." ~Easily accessible, bus/billboard advertisements ~Indicator for LEVEL of engagement, not just amount of engagement/ participation ~Conversations about engagement with local leaders/ advocates/ etc. ~What are "demographics"? -- incorporate race/ethnicity, age, class ~Indicator = materials provided to community? (vs. participation) ~See: Science Museum of VA's happiness meter ~Bus stop surveys - one-touch surveys that can be completed easily and electronically ~Use census tract and census block demographic data as an indicator. ~Is there going to be some form of incentive or program to ensure engagement and participation? ~Document locations of initiatives/events to determine ability participate ~Other event details like time of day, access by public transportation ~Measure outreach - how many people are aware of opportunity to participate? ~Language accessibility - reading level, multilingual ~On-site accessibility too (not just outreach) ~Add an education indicator here?
Improved air quality	
Indicators	Days per year with poor air quality; What is contributing to poor air quality? How do we measure reduction HERE rather than the air quality itself?
Equity Indicators	Neighborhood-level air quality (in the future; would; need routine monitors citywide); Where and on what to put these monitors? Gov't buildings, community gardens, schools, etc.
Considerations	~Post data loggers and have them be publicly available throughout the city and pull data from heat/air quality monitoring that was just conducted ~Make the schools collection sites and science teachers could be the contacts; 'where' they report the data needs to be determined; Equity indicator is stronger than "general" indicator - routine monitoring is key ~How to really measure Richmond's progress here (vs. things like wildfire haze, etc.)? ~# cars driving during hot days (which are also bad air quality; look at other cities ~Hospital data, respiratory illness ~Improved air quality BECAUSE there is more stringent regulations on polluters; target the causes of poor air quality with the indicator, not the air quality itself ~Indicator = how many DEQ air quality permits being passed ~Equity = where they are being passed ~Indicators need to be broken down by compound / particulate matter, amount of particulate matter in air ~Measuring air quality in places with higher risk (e.g., schools with kids who are still developing physiologically) needs to be prioritized ~Emphasis on Monitoring (create some metric to set in place) ~Identify where monitoring is not taking place and make sure there is monitoring stations (set up stations at community centers and schools - purple air is a resource for air quality monitoring tools) ~Rather than just improving air quality in general, close gap between areas with best and worst air quality (similar to heat) ~Look at health indicators like asthma rates; could have a separate section for "correlated" indicators (causality vs correlation) - also COPD and some others ~Virginia Clinicians for Climate Action tracking data, legislation

Increased flood resilience	
Indicators	% permeable surface (man-made or natural? - how can we separate from "more green space" outcome?); capacity of stormwater management system (upstream (e.g., flood wall) vs. downstream); Efficiency of stormwater system (i.e. backed up drains, etc.) - conditions on the ground; other stormwater capture?
Equity Indicators	# standing water and flooding complaints + calls for service (emergency) resulting from heavy precipitation and/or extreme storm events; # / where resilient development is happening?; Insurance claims
Considerations	~Disaggregate/map all these indicators by neighborhood and demographics (look at correlations between risk and past historical disinvestment) ~Connect w/ RVAH2O on data esp. automated systems because a lot of people have given up trying to reach out to the city to report issues ~Tree canopy cover also important here (but also a factor in drain clogging!); Cost of recovery after flood events as possible additional indicator ~Flash flooding (localized flooding) vs. river flooding ~# of CSO events? ~Individual reports might be challenging in terms of being a holistic look at flooding ~Permeable surfaces might not work as well once soil underneath is compacted; look at stormwater capture ~A lot of people that are impacted by flood events do not reach out to the city it may be helpful to reach out to hardware stores because after flood events they are sell out of sump pumps ~Communications/outreach (making people aware of hazard and what to do) ~Promotion and participation in city incentive programs like stormwater credits for permeable pavement, rain barrels, etc. ~Not just permeable surface - vegetation; # of people taking advantage of incentive/planting programs; plantings/upkeep of vulnerable areas and new developments ~# bldg permits issued in flood plains ~Flood insurance ~Emergency room/urgent care admissions ~Consider stationary pollution sources ~# of days of good air quality ~DEQ efforts on air permits and air quality improvements ~Equity measurement - Decrease in # of hazardous waste facilities + decreased # of ER admissions (asthma, respiratory illness)
Increased heat resilience	
Indicators	Average temperature across the city (this may not make sense given global trends in temperature - is there anything we can do that will change this?); Temperature difference between the hottest and coolest areas of the city
Equity Indicators	# heat-related illnesses, fatalities, and calls for service (mapping with neighborhoods or census tract); Neighborhood-level average temperature; # / where resilient development is happening?
Considerations	~Monitoring of industry heat output as an additional indicator? ~# of days above X deg, # of heat waves as indicators rather than blanket temps across the city ~Note Reduction of # of heat-related illnesses ....; ~Can we get this data annually? ~Use the satellite based data and/or assign a "heat value" to different surfaces to create scoring system? ~Could we use well placed weather stations as a substitute for citywide assessment? ~Reduce temp by certain %? Equitable distribution of reduction across city ~Check for guidelines on heat stress temp guidelines (OSHA) for unsafe workdays. Unsafe workdays not an equitable measure based on age and other factors - develop RVA guideline ~https://lis.virginia.gov/cgi-bin/legp604.exe?211+sum+HB805

Increased support for climate action and resilience	
Indicators	% of RVAgreen 2050 strategies with funding (from any source - city budget, private, etc.)
Equity Indicators	$ available and allocated for neighborhood-based climate action and resilience projects (in neighborhoods where health impacts are high and where flooding events are high)
Considerations	~# of staff hours? ~Define support? (support being neighborhood involvement as an equity indicator?); ~Results matter, not $ spent on it -> track the actual thing that matters (other outcomes/indicators that are results oriented) ~Look at where/how $ being spent for equity indicator - demographic groups, geographic areas - keep in mind that some communities have more need than others ~Can we add or substitute measuring community support through polls, surveys, legislation tracking (political capital?); Require annual reporting on projects success and what they did with the funding ~Community survey to gauge the level of support for climate action projects ~Increased awareness of what 'support' means from both the city's side and the community's is essential ~Need a tool to prioritize impact and equity so when we ask for funding we can easily present our % of neighborhood projects that need funding and the ones with the most impact for community that need funding (city stewards need a tool to use during budget process and/or to present to private sectors that would align with their mission statements)- (Katrina) ~How many neighborhood groups and/or community members are being asked to participate in this goal and engaging ~If we have a list of projects in the neighborhoods (e.g. recycling bins in parks, composting facilities, community gardens) and ask corporations to fund/sponsor and we track ~Increasing funding and where that money is coming from is important. ~Funding is often offered for implementation and not maintenance ~We need clarity around what does increase in funding actually mean? ~Which RVAgreen 2050 strategies are receiving funding and did it get prioritized and funded through an equitable lens ~Does this funding include staffing/capacity building, who is going to do the work? ~# of staff hours? ~# of communities served and communities reached and events held and participants engaged and developed at the neighborhood level (i.e. HOA involved in climate action & resilience for their neighbors), touchpoints with legislation, media hits, # of thought leadership pieces (published) ~Facilitate post event evaluations to gauge how people think events went / identify what we can do better ~# of partners (who they are and who they are helping) ~There has to be a buy-in from certain communities where the support for projects that enhance a healthier climate is demanded.
Less landfill waste	
Indicators	Annual tonnage of waste going to landfill; % waste being diverted from landfill to be recycled or composted"
Equity Indicators	% waste being diverted from landfill by neighborhood; # of illegal dump sites by neighborhood & # of times cleaned up

Considerations	~Commercial #s are an issue so we would need to develop a protocol to collecting this numbers accurately ~Coordinate with NOPE and other haulers to develop methodology for calculating ~% of population that doesn't have recycling services available and where they are (including businesses) - look to Fairfax as a model ~Capture waste reduction/reuse concept (Repair events can help with keeping items out of the landfill which would help with frustration levels of citizens plus there is an economic benefit. There could be a count of items repaired (usually held at community centers of churches). Difficult to calculate this...how? ~Increase in % of households that are recycling and composting as an indicator? ~Access to facilities/system to recycle - #/% of landlords that have system for tenants to recycle
Lower greenhouse gas emissions	
Indicators	Community-wide greenhouse gas emissions; City government greenhouse gas emissions
Equity Indicators	GHG emissions per capita disaggregated by neighborhood, race and income
Considerations	~Key factors: heating fuel, residents per dwelling, commuting habits, cooling type, building age, grid fuel mix, ~Be very clear about what data we can access and assumptions we can make, and therefore here's what we can glean from that; Consider access to resources (e.g. recycling bins and efficient buildings) in these neighborhoods to help communicate the importance of lowering carbon footprint and measuring the progress (targeted outreach and engagement especially important) ~Define GHGs that have the most impact (e.g. if more ridership on buses in a certain neighborhood is that where we put our 'clean' buses?)- prioritize communities with the greatest impact and then wrap/concentrate the projects around them
More green space and trees	
Indicators	% tree canopy cover overall (NOT lawns/turf); % people within 10 minute walk of a park (consider quality rating, amenities, size of park to create a standard definition of what a "park" is to use for this indicator)
Equity Indicators	% tree canopy cover by neighborhood (and/or Council districts/census tracts - correlation with race/income); % people within 10 minute walk of a park disaggregated by neighborhood, race and income; Input from users of green space and ability to inform what that space looks like (e.g., basketball court vs. forested park area); increase in diversity of park visitors / users (how to measure?)
Considerations	~% tree canopy cover - satellite data? Look at change over time (reduction in impervious services) ~Analysis on change over time can be conducted using GIS NDVI Analysis ~10 min walk- what is the quality of the park (sport field vs. tree canopy) what does the park offer the people. Size of park. Connected vs. non connected green space. Safety associated with that 10min walk (speed limits, quality of sidewalk); Clarify the 10 min walk - not always a safe walk (don't just use concentric circles) - do road network analysis ~What geographic area could we do for tree canopy? Can we go as small as census block group? Neighborhood lines don't overlap nicely ~How often is tree canopy imagery data updated? ~Partner w/ universities on tree canopy indicator ~What is the "official map"? What constitutes tree canopy? ~What constitutes a successful increase in the tree canopy? ~Scaling what a 10 min walk looks like (not going to be enjoyable if it is in pure sunlight vs. a shaded walk.)

The questions that were reviewed by staff in order to identify the appropriate indicators were:

1. What are the data points that we are currently tracking?
2. What data points are other departments tracking?
3. What data points will we be required to track in the future?
4. What data points do we already have access to? If not, how could we get them?
5. Of these data points, which ones demonstrate progress toward which outcomes?
6. What data points would demonstrate equitable progress toward each of the outcomes?
7. Can the data point be disaggregated by race, income, or other factors?
8. What data points do our peer cities track for their milestones, targets and goals?
9. What data points can we realistically commit to reporting on annually?
10. Which data points can be reported on bi-annually?

In the end, the following data points and data sources were identified for each of the outcomes in consideration of the questions above and the principles of the SMARTIE Model:

OUTCOME	INDICATOR	DATA SOURCE & NOTES
Advanced green economy	Number and percentage of green jobs	To be determined: In 2013 the U.S. Bureau of Labor Statistics eliminated its Green Goods and Services Occupations data and publications program. Alternative methodology to be identified using best practices and peer city research.
	Number of residents completing training, education, and apprenticeship programs related to climate action and resilience by race and ethnicity	City departments, higher education institutions, and partner organizations
Cleaner and more efficient buildings	Total building energy use (Btu)	Dominion Energy, CIty of Richmond
	Percentage of households with high energy burden by race and ethnicity	U.S. Census*
Cleaner and more efficient transportation	Percentage of travel (mode share) not with single-occupancy internal combustion engine vehicles	U.S. Census*
	Percentage of population within a 10 minute walk of a fixed-route transit stop with amenities by race and ethnicity	U.S. Census + Greater Richmond Transit Company (GRTC)
Climate-ready community	Number of residents receiving information on climate change impacts through website, social media, events, trainings, and other communications channels (to be defined)	To be determined; methodology to be developed using Office of Sustainability communications platforms and tracking information.
	Percentage of population facing "high vulnerability" to climate change per the Climate Equity Index by race and ethnicity	RVAgreen 2050 Climate Equity Index
Engaged and involved community	Number of respondents to annual sustainability survey (online, paper, phone, and in-person)	Annual community survey
	Number of respondents to annual sustainability survey (online, paper, phone, and in-person) by race, ethnicity, and income - compare to citywide demographics	Annual community survey
Improved air quality	Citywide average Air Quality Equity Score	To be determined: methodology to be developed with community partners modeled after Tree Equity Score; data to be gathered when air quality monitoring network is established (est. 2023/24).
	Average Air Quality Equity Score by race and ethnicity	To be determined: methodology to be developed with community partners modeled after Tree Equity Score; data to be gathered when air quality monitoring network is established (est. 2023/24).

OUTCOME	INDICATOR	DATA SOURCE & NOTES
Increased flood resilience	Number of incidents of standing water, flooding, and emergency service during heavy precipitation events	Assemble data from RVA311, emergency service providers, and other sources to be identified
	Number of calls/311 requests for standing water, flooding, and emergency service during heavy precipitation events by census tract (and/or race and ethnicity if available)	Assemble data from RVA311, emergency service providers, and other sources to be identified
Increased heat resilience	Temperature difference between hottest and coolest areas of the city	Urban heat island study and/or satellite data
	Percent of population facing "high heat vulnerability" to climate change per the Climate Equity Index by race and ethnicity-race and ethnicity don't predict vulnerability	RVAgreen 2050 Climate Equity Index
Increased support for climate action and resilience	Percentage of RVAgreen 2050 actions funded	City budget
	Annual $ allocated directly from the city or facilitated through a partnership with the city to community organizations for neighborhood-based climate action and resilience projects	City budget
Less landfill waste	Total waste going to landfill (tons)	Transfer station operator and private haulers
	Percentage of households that have access to curbside/on-site recycling services by census tract	U.S. Census*
Lower greenhouse gas emissions	Total community GHG emissions (MTCO2e)	Office of Sustainability greenhouse gas emissions inventory
	Per capita GHG emissions by census tract (MTCO2e)	Office of Sustainability greenhouse gas emissions inventory - calculation methodology to be developed with community partners
More green space and trees	Citywide average Tree Equity Score	American Forests Tree Equity Score Tool
	Percentage of population within a 10 minute walk of a public park with green space by race and ethnicity	U.S. Census* + Department of Parks and Recreation data

**The Office of Sustainability is currently evaluating the results of the 2020 census due to emerging concerns over equity, accuracy, and representation. RVAgreen 2050 staff will monitor the ongoing discussion and identify new data sources as needed.*

This iterative process allowed us to identify and fully understand the metrics that impact the overall success of the plan. This will both streamline the annual assessment process and inform comprehensive reporting that will move beyond isolated incidents of project success.

Appendix J
Full List of 188 Initial Strategies

Appendix J: Full List of Strategies Prior to Prioritization

Buildings & Energy: Accelerate the equitable transition to healthy, resilient, climate neutral buildings and energy sources

Objective 1: Achieve climate neutrality and increase resilience in government buildings, infrastructure, and operations.	Methane Leakage: Minimize methane leakage: (1) Ensure Richmond Gasworks leaks identified in leak surveys are addressed quickly in order to minimize leakage and improve resilience. (2) Assign staff responsible for tracking and advocating for the reduction of upstream methane leakage.
	Carbon Offsets: Develop criteria to determine which buildings cannot be made neutral and identify carbon offsets in lieu of retrofits.
	Electrification: Catalog and track natural gas usage in all buildings and develop capital improvement plans (CIPs) to convert buildings to clean energy by 2050.
	New Construction: Require all new municipal building construction to achieve net zero energy. Incorporate the infrastructure required to make them solar-ready, wired for EV chargers, and compatible for demand response enrollment.
	Energy Resource Center: Establish a Local Energy Resource Center and online hub through partnerships with utilities, educational institutions, and other organizations to provide centralized clean energy information and workforce development training programs for well-paying clean energy jobs.
	Climate Projections- Planning: Incorporate a review of City operations every 5 years to identify opportunities to address climate impacts and incorporate climate projections into land use planning, building regulations, and capital investments prior to implementation.
	Climate Projections- Tracking: Create departmental greenhouse gas emissions tracking protocol and identify reduction opportunities. Publicize key performance indicators (KPIs) quarterly and incorporate data and equity into performance based budgeting.
	Climate Projections- Contracts: Phase out fossil fuel dependence in all city agreements and contracts by giving preference to companies that reduce the city's energy footprint.
	Energy Management Program-Benchmarking: Develop a municipal energy management program to benchmark energy use in all city buildings, set a goal to meet Energy Star certification guidelines, improve building energy use, and make information available in a public portal.
	Energy Management Program-Staff: Create cabinet-level Energy Manager position reporting directly to Senior Administration with authority to work across departments and establish partnerships in the community to achieve energy efficiency goals of RVAgreen 2050 and Richmond 300.
	Energy Management Program-Retrofits: Prioritize energy efficiency retrofits of city buildings in those that serve the public therefore improving their health, safety, and accessibility while rating the highest return on investment in cost savings and greenhouse gas reductions.
	Green Roofs: Evaluate municipal facilities to identify green roof candidates. Develop green roof design standards and install green roofs in areas that will benefit most from increased green space, reduced stormwater runoff, and cost reductions.
	LED Streetlights: Convert all city-owned streetlights to LED lighting and identify opportunities for solar panels in the lighting infrastructure. Prioritize improvements in historically disenfranchised neighborhoods.
	Municipal Solar: Develop a municipal renewable energy goal and draft corresponding ordinance for city council adoption.
	Climate Vulnerability & Risk Assessment: Conduct a climate vulnerability and risk assessment of all city property (including buildings and parcels). Identify and prioritize properties for specific resilience projects.
	Workforce Development: Provide local job training and employment opportunities related to resilient infrastructure (e.g., conducting resilience audits and hotline operations).

Objective 2: Maximize energy efficiency, performance and resilience in all existing buildings.	Energy Code Adoption: Work with allied organizations to encourage the Board of Housing and Community Development to adopt the most recent International Energy Conservation Code (IECC) for all commercial and residential buildings.
	Enforcement: Train building inspectors and cultivate the department's capacity to enforce letter and spirit of current building code provisions related to energy efficiency requirements during plan review.
	Education-Refrigerant Recycling: Work with refrigerant recycling and disposal operators to promote the benefits of switching from hydrofluorocarbon (HFC) refrigerants to cost-effective alternatives.
	Electrification: Promote the benefits of electric-only commercial and residential retrofits by sharing targeted case studies in the areas of highest utility burden.
	Financing: Divert investment in gas utility upgrades to all-electric conversions.
	Energy Reporting: Benchmark existing commercial buildings to establish a baseline and conduct ongoing measuring/tracking in conjunction with energy audits and retrofits.
	Performance Standards: Require an equitable building performance standard for existing commercial buildings over 5,000 sf through a phased-approach. Offer assistance and technical expertise to those that are financially challenged and facilitate workforce development opportunities.
	Retrocommissioning: Require retrocommissioning for existing commercial buildings to improve the efficiency of a buidling's equipment and systems. Offer assistance and technical expertise to those that are financially challenged and facilitate workforce development.
	Energy Efficiency Financing: Create a Commercial Property Assessed Clean Energy (CPACE) program or join the statewide program when launched. Encourage builders and developers to hire Small, Women-owned and Minority-owned businesses (SWaM).
	Green Business Challenge: Develop and promote a voluntary green business challenge and/or certification program that prioritizes small businesses in underserved communities.
	Combined Heat & Power: Promote the use of combined heat and power (CHP) in industrial facilities and the use of PACE to finance CHP systems while considering environmental impacts to neighboring communities.
	Energy Resource Guide: Develop a community energy resource guide that is equitable and accessible.
	Energy Efficiency Assistance: Aid households that have the highest energy burden with energy efficiency upgrades through community-based programs, advocacy, partnerships, and Residential PACE (Property Assessed Clean Energy)
	Energy Reporting: Advocate for the General Assembly to adopt enabling legislation allowing localities to require residential energy benchmarking and public disclosure, and adopt a local ordinance.
	Equitable Thermal Comfort: Establish partnerships and identify existing programs to provide immediate cooling relief in the way of equipment, tree canopy, and utility bill assistance to low income residents and/or residents of formerly redlined neighborhoods and heat islands.
Objective 3: Ensure all Richmonders have equitable access to affordable and renewable clean energy.	Microgrids: Increase funding for community-based organizations to adopt carbon-free microgrids and battery backup for energy storage, particularly in frontline communities.
	Ground-Mounted Solar: Incentivize opportunities for local ground-mounted solar and community solar farms on parking lots, non-buildable, or previously disturbed land, with access to community solar for energy-burdened communities.
	Incentives: Adopt an ordinance to fully exempt solar from property tax increases, per VA state energy code Section 58.1-3660 and 3661.
	Accessibility: Review existing zoning ordinances and policies for impediments to renewable energy and revise them to reduce all barriers (e.g., revise zoning ordinances to allow solar and battery storage to be placed in more places).
	Energy Education: Monitor, track, and publish Richmond's energy use by source, making data more accessible for education, accountability, and transparency purposes.

	Solar Installations: Provide financial assistance and education for clean energy upgrades and retrofits to make homes and small businesses healthy, safe, and affordable, focusing on frontline communities reducing disproportionately high energy burden in these neighborhoods.
	Workforce Development: Establish training programs, apprenticeships and a conservation corps/job placement program in low-income and diverse neighborhoods to build capacity for jobs related to solar installation and maintenance as well as weatherization upgrades and energy efficiency auditing (e.g., prison to solar training).
Objective 4: Achieve climate neutrality and maximize resilience in all new buildings.	Net Zero Energy Design: Promote legislation that allows for adoption of building codes requiring all new buildings to be powered by clean energy with the goal of net-zero energy design.
	Solar Readiness: Have a solar readiness requirement for all new buildings.
	Demonstration Project: Partner with developers to help finance and construct a demonstration project, ideally a municipal building, that provides proof of concept in designing and building a net zero building using established programs and methods (e.g. LEED, Passive House, Green Globes, etc).
	Financing: Develop a central repository of funding opportunities and incentives for green and net-zero construction that supports the local labor workforce with a focus on affordable housing in frontline neighborhoods.
	Design Guidelines: Develop Resilient Design Guidelines and encourage builders to incorporate design measures to reflect a changing climate, increased precipitation and flooding in concert with a public education campaign to convey the benefits of adaptive and resilient buildings.
	Utility Resilience: Advocate for and require the inclusion of climate resilience measures with clear procedures to combat extreme precipitation and flooding in all Dominion Energy infrastructure improvements.

Community: Create an equitable and resilient Richmond while honoring and ensuring focus on community priorities

Objective 1. Ensure that historically disinvested communities that are most affected by local climate impacts are centered and involved in the processes of developing, implementing, and evaluating solutions as a result of equitable communication and engagement strategies.	Community Benefit Agreements - Develop community benefit agreements with target community members, which could include items such as creating jobs, utilizing local workforce development agencies to assist with hiring local, creating public open space, creating climate resilient low-income housing, and more
	Scorecard - Develop public scorecard to evaluate projects with SMARTIE strategies and mandate XX equity goals, including items such as ensuring residents within a community are first hired/considered for development projects and the inclusion of a funded maintenance plan
	Funding Priorities - Ensure that funding priorities are based on priorities established by neighborhood participation and allocated by a commission/board/entity with community representation
	Carbon Offsets - In the event that carbon offsets are needed to meet the 2030 greenhouse gas emissions reduction goal, work with the community to develop criteria for types of offset credits to purchase.
	Targeted Methods - Develop a set of unique and targeting engagement methods, beyond conventional surveys and town halls, to engage traditionally under-represented groups in the planning process.
	Quarterly Events - Host quarterly events about RVAgreen 2050 to ensure Richmond's existing and new residents are aware of the visions, goals, objectives, and strategies outlined in the plan.
	Internet Access - Improve communications infrastructure by expanding broadband internet access, focusing on low-income areas (Goal 11).
	Translations - Engage residents with culturally relevant material available in multiple languages including braille.
	Media - Implement engagement strategies that focus on information sharing media (virtual and physical) where target communities already engage. In partnership with TV services providers, radio stations, local print, social media create media focused on climate action and resilience (podcast, educational videos) that reach target populations.

	Digital Guidelines - Develop guidelines for digital/virtual media development and uses that includes mobile optimization for all virtual media developed including: recording, interpretation (including American Sign Language), captions, and graphics
	Community Ambassadors - Leverage existing community connections (such as community ambassadors, local celebrities, and other trusted groups) to provide and receive information about resources and environmental threats to build trust.
	Neighborhood Character - Increase education and outreach efforts regarding the preservation of neighborhood character and available incentive programs for historic preservation, adaptive reuse, and place based economic development.
	Community Participation - Create a Richmond planning, climate action, climate resilience knowledge program administered by the Office of Sustainability for everyday Richmonders to learn about the planning process and understand how their voices can be incorporated into the planning decision-making processes both local and state level.
	Small Business Assistance - Create a business guide to help existing, new, and small businesses navigate City incentive programs and permitting, building code, zoning, and licensing processes.
	Community Prioritization - Ensure that climate action and resilience projects include prioritization education and identify communities most impacted by climate change and establish objective guidelines for geographic placement of projects and funding. Develop planning on how neighborhood prioritization is established.
	Communications Guidelines - Develop guidelines for visual communication development and make sure that members of the target community are included (if not in control) of the strategy. -includes showing the disparities between neighborhoods
	Low Income Tax Assessments - Advocate for a tax fund to help qualifying low income residents remain in their homes as their assessments increase.
	Climate Impact Grant - Provide a grant program through the creation of a climate impact fund to help target communities recover from extreme weather events, weatherization of homes, and appliance ownership and provide grant opportunities for local nonprofits to work on climate action and resilience projects in target neighborhoods
	Community Engagement - Establish budget guidelines for engagement and education funding to keep residents informed on RVAgreen 2050 strategies and establish payments for residents to work with RVAgreen 2050
	Telework Incentives - Levy a tax for businesses larger than XX employees that do not facilitate telework on a full-time or rotational basis or offset the cost of alternative transportation options
	Community Projects - Identify sources of funding for climate action and resilience projects that include but are not limited to: CDFIs, bank loans with low interest rates, partnership with businesses to fund projects in targeted communities
	Affordable Housing Trust Fund - Increase funding for and transparency of the Affordable Housing Trust Fund and develop and fund a housing policy educational program for newly elected officials and City staff involved in planning, housing, climate resilience, and community development activities.
	Neighborhood Partnerships - Encourage organizations (higher education, Richmond Public Schools, early education groups) to create neighborhood partnerships to develop local climate programs (horticulture, health, urban design), liaison with communities, and engage in action-learning climate projects within communities
	Homeless Populations - Expand partnerships serving the homeless to provide small year-round emergency housing facilities in areas of high climate vulnerability for all homeless populations that include supportive services and food
	Public Libraries - Establish a partnership with Richmond Public Libraries to offer relevant programming and book recommendations to help connect residents to climate action and resilience goals.
	Community Foundation - Partner with the Office of Public Engagement to utilize Community Foundation's Hands On site to help organizations identify projects that align with the objectives and strategies of RVAgreen 2050 to identify and streamline partnerships, volunteer opportunities, and community priorities - focus on businesses that provide a livable wage to employees

	City Government Departments - Identify City of Richmond departments and offices to partner and align goals of RVAgreen 2050
2. Increase the Richmond community's social resilience to climate change.	Community Response - Encourage citizens to check on family, friends, and neighbors during extreme heat events and natural disasters (look at expanding existing the existing Community Emergency Response Teams program).
	Resilience Fairs - Host "resilience fairs" where residents and connect with information and services at regular intervals, particularly in communities on the frontlines of climate change.
	Health & Wellness - Build capacity among healthcare professionals, health-related and neighborhood volunteer networks, and others to communicate about responses to climate-related health issues.
	Resilience Hubs - Identify community facilities, such as community centers and libraries, to serve as resilience hubs and provide funding to provide these as resources to the community.
	Cooling Centers - Identify multiple locations across the city to serve as permanent community cooling centers, particularly in areas with low-income, elderly, young, and homeless populations.
	Emergency Housing - In addition to strategies contained in the Richmond 300 Master Plan to increase emergency housing facilities, work with relevant city departments and partner organizations to protect the houseless population during extreme weather events, including education and awareness-building among staff and residents.
	Residential Assistance - Identify, evaluate, improve where needed, and market existing programs to assist residents before, during, and after extreme weather events, including those addressing human health impacts from chronic issues such as moisture and mold.
	Emergency Preparedness - Evaluate existing City operations plans for and build staff capacity for responding to issues related to climate resilience and emergency preparedness. This should include adding a Heat Emergency Action Plan to the existing emergency operations plan.
	Disaster Response - Broaden the review of the city's Emergency Operations Plan and related documents to include community stakeholders and subject matter experts to ensure that disaster related response and recovery efforts are inclusive and equitable regardless of the emergency.
	Community Response Fund - Establish a permanent fund - either within the City budget or through a regional partnership such as with the Community Foundation - to provide direct and immediate assistance to community organizations that assist residents before, during, and after extreme weather events. Eligible expenses should include home repairs, healthcare costs, among others.
	Community Stakeholders - Pay community members from historically disenfranchised communities that will be most impacted by climate change for their expertise and time in the process of developing, implementing and evaluating solutions as community leaders on climate action and resilience.
	Organizational Collaboration - Connect community leaders, public health and healthcare infrastructure, local nonprofits, and businesses to one another to collaboratively identify neighborhood resources for emergencies and develop community asset maps to increase climate resilience.
	Cooling Equipment - Partner with rental property management companies and individuals to provide efficient cooling equipment to residents and explore creating and/or advocating for a mandate that landlords provide air conditioning in all rental properties.

Environment: Invest in resilient, healthy, and equitably distributed natural resources throughout the community to support biodiversity and human well-being

Objective 1: Make sure all residents have the opportunity to engage with	Private Property - Generate "rubber-stamped" park and green infrastructure that can be installed by community members by-right on private property.
	Awareness - Create a program to introduce Richmonders to the city's public green and blue spaces (including how to get to them, how to use them responsibly, etc.) that is tailored to individual interests, physical ability, and other factors.

healthy natural resources, spaces, and biodiversity.	Enrichmond Tree Lab - Develop a program in partnership with Enrichmond Tree Lab for residents and neighborhoods to "report" desire for things like more street trees and plantings.
	Adopt-a-Spot Program - Expand the City's Adopt-a-Spot Program to include waterways, greenways, and bike lanes.
	Richmond Public Lands Day - Establish the fourth Saturday in September as Richmond Public Lands Day in which residents and city staff are encouraged to enjoy, steward, and celebrate their local park (aligning with national and state public lands days).
	Public-Private - Create public-private partnerships to help the City create, maintain, and manage high-quality parks, green infrastructure, and public open space, including a privately-owned public space program to incentivize private land owners and/or developers to include publicly-accessible green/open space in underserved areas (a recreational easement program).
	Regional Collaboration - Collaborate with surrounding localities to cross-promote public green spaces and parks.
	Parks Master Plan - Develop a Parks Master Plan providing all Richmonders access to a quality public park that meets the surrounding community's priorities within a 5-minute walk, bike, or bus ride. Prioritize locations based on a set of factors co-created with the community.
	Green Infrastructure Fund - Establish a fee or fund for parks and green infrastructure maintenance and the acquisition of new green space, such as $0.005 per dollar of real estate taxes or parking fees for non-city residents at high-use locations on summer weekends.
	Staffing - Create a permanent office/position within the Department of Parks, Recreation and Community Facilities to manage partnership and volunteer programs.
	Community Gardening - Develop - and make visible and accessible - an urban agriculture program that partners with food justice community organizations and includes an apprenticeship training program. Identify changes needed in the community garden ordinances for sales and increased funding for staffing, maintenance, and materials needed. Incentivize owners of multifamily dwellings to remove barriers to individuals growing their own food and allow universal access to community gardening and composting.
Objective 2: Reduce risks and impacts to the community and natural environment from extreme heat and drought.	Green Space Guidance - Create a citywide definition of quality green space that provides guidance on these and other strategies, which includes information on the types of spaces that provide co-benefits for climate resilience.
	Staffing - Increase city capacity (internally and through community partnerships) for maintenance of existing resources that enhance extreme heat and drought resilience by increasing maintenance budget, hiring more staff (including through a workforce development program), and providing staff training and engagement opportunities to increase buy-in and decrease turnover.
	Urban Heat Islands - Develop an urban heat island readiness and reduction plan with a focus on vulnerable populations and ecosystems. Include tactics such as mandating benches and shade structures at all bus stops and establishing “rubber-stamped” shade structure designs that businesses can build and install in the public right-of-way.
	Cost of Inaction - Develop a study that quantifies the “cost of inaction” on key assets and neighborhoods at risk from extreme heat and drought.
	Urban Forest Master Plan - Develop an urban forest master plan, engaging the community to develop a set of criteria for places to focus planting efforts (factors such as existing canopy, heat, plantable space, others).
	Impervious Surface Requirements - Establish requirements for major development related to impervious surface that ensures impervious surface area does not increase during the development or once it is completed.
	Adopt-a-Tree Program - Evaluate the city's Adopt-A-Tree program and identify opportunities for expansion, such as allowing community organizations to buy trees in bulk and committing to caring for the trees.
	Depaving - Develop a plan and program for depaving impervious surfaces that includes an ordinance to allow non-DPW entities to conduct depaving projects and standards/guidelines for such projects.
	Mayor's Green Team - Implement the recommendations of the Mayor's Green Team (2020), including fostering interdepartmental cooperation and coordination on green space and parks projects and adopting the use of proffers or impact fees on new developments to increase green space and tree canopy.

	Invasive Species - Conduct an assessment of how climate changes will impact the presence of invasive species and create a plan for control and minimizing presence and impacts.
	Conservation - Incentivize reduced water consumption by revising Dept. of Public Utilities billing structure and methods.
Objective 3: Reduce risks and impacts to the community and natural environment from extreme precipitation and flooding.	Neighborhood Prioritization - Use community input and data (such as the Climate Equity Index, RVA311, RVAH2O, and other sources) to identify and prioritize neighborhoods for extreme precipitation and flooding resilience projects including assessing existing stormwater infrastructure, green alleyways, stream restoration, and depaving.
	Flood-Prone Land - Identify opportunities for the city to acquire flood-prone (and other) land to increase resilience to flooding.
	Conservation Easements - Create a Clean Water Revolving Loan Fund to encourage and compensate landowners for placing flood-prone private land into conservation easements, prioritizing areas in historically disenfranchised communities.
	Reduced Mowing - Convert large City-managed non-recreational mown areas, such as floodwall impoundment areas, to native community wildflower/pollinator species meadows, mown or bush-hogged once or twice each year.
	Riparian Development - Restrict development in riparian areas and identify locations for and engage developers on development of low flood risk areas.
	Green Infrastructure Master Plan - Implement the Green Infrastructure Master Plan to expand green infrastructure on public lands and rights-of-way through city projects and community partnerships, and include public engagement and education programs.
	Capacity and Resources - Increase city capacity for maintenance of existing resources that enhance flood resilience by increasing maintenance budget, hiring more staff (including through a workforce development program), and providing staff training and engagement opportunities to increase buy-in and decrease turnover.
	Zoning and Permitting - Create incentives or requirements in zoning and development processes (such as proffers or impact fees) for green infrastructure on new development.
	Project Management Portal - Create an integrated project management portal to streamline administration and permitting of public-private partnership projects that increase resilience to the impacts of climate change, such as green infrastructure installations.
	Wetlands Management - Partner with upstream counties and the Department of Environmental Quality on preserving wetlands to reduce downstream flooding impacts in Richmond.
	Cost of Inaction - Develop a study that quantifies the “cost of inaction” on key assets and neighborhoods at risk from extreme precipitation and flooding.
	Stormwater Credit Program - Market the City's stormwater credit program, and explore changes to the program to increase its use and encourage more landowners to plant vegetation that reduces the quantity and improves the quality of stormwater runoff (i.e., actions that are qualified Best Management Practices under the Chesapeake Bay Program).
Objective 4: Engage the natural environment to improve air quality and reduce greenhouse gas emissions.	Pollution Sources - Conduct an assessment of sources of air pollution in the city and identify opportunities for reduction through green space, tree, and other projects that also increase access to natural resources in combination with the strategies above.
	Parks & Public Spaces - Prioritize deep root, native plantings in parks and other public green spaces, buildings, schools, and public housing to maximize carbon sequestration.
	Exploration - Explore potential for carbon farming, sequestration, and removal on vacant public or private land, throughout the City's parks and open space system, and in coordination with other public landowners, prioritizing investments in frontline communities where feasible.
	Green Jobs Incubator - Evaluate the potential for a Carbon Sequestration Incubator develop green jobs in urban agriculture, urban forestry, aquatic and riparian restoration, engineering technology, and/or other forms of carbon farming, sequestration, and removal.

Transportation & Mobility: Accelerate the transition for all to clean and equitable mobility systems

Objective 1: Achieve climate neutrality in municipal fleet operations and increase resilience and stewardship of transportation infrastructure.	Complete Streets - Promote stewardship of the City's Better Streets policy between neighborhoods by connecting areas and green space in order to promote walkability and continuity for all modes of transportation, including transit, bicycles, and micromobility (e.g. scooters, mopeds, e-bikes, etc..).
	Innovation - Create an equitable research and tracking method to regularly consider emerging technologies that could facilitate further carbon reductions and improve resilience of the Richmond transportation sector.
	Fleet Electrification - Develop a municipal fleet electrification plan for all new vehicles and equipment purchases.
	Alternative Fuel Vehicles - Incorporate alternative fuel vehicles in the City fleet to reduce carbon emissions when electric vehicle options are not viable. Support the local economy through local biofuel / negative carbon opportunities, generate workforce development, and identify potential climate resilience and redundancy measures of alternative fuels.
	Purchasing - Implement recommendations of Clean and Green Fleet Report and require all new vehicle purchases to evaluate electric options that incorporate full life cycle costs and the social cost of carbon in budget forecasting.
	Charging Infrastructure - Install electric vehicle charging stations in all city-owned parking lots per recommended in the Clean and Green Fleet Report and incorporate climate resilience measures in all installations. Set goals for increasing access of City employees to charging infrastructure at work.
	Resilience Maintenance Plan - Develop a Climate Resiliency Maintenance Plan for transportation infrastructure using the Climate Equity Index to prioritize budget requests for resilient maintenance of all bridges, roads, sidewalks, and alleys. Ensure that City infrastructure projects are sited to avoid/minimize impacts to natural resiliency features such as wetlands, forests, and vegetated riparian buffers.
	Smart Infrastructure - Implement smart infrastructure using IoT (Internet of Things) technologies that prioritize equity, accessibility, and efficiency.
	Transportation Demand Management - Reduce emissions in city operations through the support of employee commute alternatives such as transit and bicycle storage facilities, optimized vehicle routing, telecommuting, and enforcement of the anti-Idling policy among city employee drivers.
Objective 2: Create vibrant neighborhoods where all residents can easily ride transit, walk, or bike to meet daily needs in alignment with Richmond Connects.	Sidewalk Networks - Implement pedestrian-friendly (ADA compliant, street trees, and pedestrian-level solar-powered LED lighting) networks through beautification and placemaking efforts prioritizing underserved communities and those with low car-ownership.
	Curbside Management - Develop and enhance curbside management programs that expand and enhance the convenience and accessibility of shared mobility options.
	Greenways- Develop shared-use paths prioritizing the connection of low income neighborhoods to jobs, necessities, amenities, green spaces, natural resources and local and regional greenways to empower residents to safely use and protect their biking and walking infrastructure.
	Bicycle Master Plan- Prioritize the expansion and improvement of pedestrian and bicycle infrastructure to all areas of Richmond through the City's budgeting process.
	Bus Service - Improve public transit frequency, reliability, access, convenience, user experience, and local and regional connectivity. Prioritize underserved communities by connecting high-density housing to shopping and jobs.
	Bus Stops - Improve and maintain priority transit stops in low-income and low car ownership areas with amenities for enhanced safety, accessibility, convenience, and resilience.
	Bike Share - Expand the bike share program citywide and make it accessible and affordable for all residents.
	Resilience Measures - Strategically integrate street trees with public transit, biking and walking infrastructure to increase shade and improve stormwater management to minimize the potential impacts of flooding and heat.

	Transportation Demand Management (TDM) - Expand and promote TDM programs community wide. Investigate partnerships with Transit Network Companies (TNCs) and other transportation providers as viable options for mobility and last-mile connectivity.
	Reduce Congestion - Implement congestion pricing/Go Zones to reduce travel demand and boost ridership per vehicle (public and private) through measures such as ridesharing and carpooling.
Objective 3: Transition the community rapidly and equitably to clean-fuel vehicles and transit.	Public Engagement - Identify and participate in strategic engagement opportunities to educate the public alongside partner organizations and city commissions about the transition to vehicle electrification.
	Anti-Idling: Provide education to all Richmonders in order to significantly reduce exhaust emissions from vehicle idling.
	Private Engagement - Engage state and federal leaders to educate fleet managers in the benefits of electric vehicle policy adoption.
	Private Vehicles - Facilitate transitions to affordable and convenient electric vehicles for all Richmonders.
	Transit Vehicles - Facilitate the transition to electric vehicles for buses, shared vehicles, and vehicles for hire.
	Charging Infrastructure - Support the equitable build-out of electric vehicle charging stations throughout the City. Encourage the installation of electric charging infrastructure by private entities and review potential barriers to expanding charging in existing City codes/ordinances.
	Battery Backup - Consider opportunities for electric vehicles to serve as battery backup for electric grid resiliency.
	Solar Backup - Evaluate on-site solar power as resilience measures for electric vehicle charging.

Waste Reduction & Recovery: Fostering sustainable methods of waste reduction - wasting less, reusing more

Objective 1: Model zero waste through municipal operations.	Model Zero Waste Internally - Track and visibly promote large-scale climate neutrality efforts and implement strategies that incentivize behavior change among city employees, such as elimination of desk-side trash bins, removal of single-use plastics and Styrofoam, and regular waste minimization and sustainability trainings.
	Institutional Best Practices - Seek cost-effective best practices among institutional partners and identify opportunities for collaborations in order to minimize waste.
	Community Partnerships - Think Globally, Act Locally - Create regional and intersectional partnerships across Richmond's neighborhoods, government agencies and community sectors to promote and educate about a holistic and unified waste reduction and recovery framework.
	Model Zero Waste Externally - Develop an aggressive public education and awareness campaign that focuses on high-traffic municipal properties (e.g., bus stops, parks) to encourage and promote effective waste reduction and recovery.
	Composting - Conduct food waste and diversion education and awareness activities and provide options for composting in all city-owned buildings, parks, and facilities. Make compost and mulch available to city properties, residents, and small businesses.
	Zero Waste - City operation will demonstrate high-impact zero waste practices in its design and expansion. The city will lead by example, aligning with the community's broader goals to educate and prepare the next generation.
	Consumption - Implement a climate neutral and waste-free city procurement policy that removes single-use plastics and minimizes upstream emissions in all municipal purchase agreements. Incentivize local, small, and minority-owned businesses to meet purchasing expectations and provide sufficient staff resources for policy enforcement.
	Solid Waste Management - Build municipal proactive and resilient safeguards to protect the most vulnerable populations from the climate impacts of catastrophic events (i.e. increased population, flooding, heat, air pollutants, and unavailability of landfills). Facilitate alliances for regional cooperation and system redundancy to strengthen resilience.

	Tracking - Conduct an internal waste audit to assess waste streams and their recovery, recycling, and disposal in order to prioritize waste reduction efforts.
	Litter- Install "band-along" traps to capture trash, litter, and other debris from the stormwater system, starting with segments that are most impacted by foreign debris and litter.
	Waste to Energy - Expand anaerobic digestion processes at the wastewater treatment plant to generate more biofuels and minimize landfilled waste.
Objective 2: Reduce commercial waste.	Construction Debris - Update construction standards to require permanent siting and staging for recycling and composting receptacles as well as adding requirements for construction and demolition material recycling reporting.
	Recycling Infrastructure & Site Plan Review - Include requirements for on-site recycling and composting collection in all permits for commercial buildings. Support small businesses by creating a sustainable waste reduction program that can be easily implemented and replicated.
	Business Development - Make Richmond a leader in attracting companies that promote a circular economy through creative and innovative solutions to waste reduction and recovery.
	Community Sharing - Promote a circular economy by fostering community spaces for sharing resources and sponsoring fairs and workshops for reuse, rental, and repair.
	Upstream Emissions - Partner with manufacturers to reduce solid waste generation through 'reparability' of products, transitioning materials used in packaging, and promoting zero waste initiatives. For example, incentivize repair shops to market services that encourage citizens to extend the life of existing objects while reducing waste as well as reducing upstream emissions for new materials.
	Commercial Services - Incentivize and support the creation of facilities and services to provide equitable access to organic waste collection and composting.
	Commercial Composting - Provide education and incentives for effective organic waste reduction at all commercial buildings.
	Policy - Pass ordinance to impose tax on plastic bags per state enabling legislation; phasing out of polystyrene containers; and balloon release bans. Advocate for a bottle deposit bill in the General Assembly.
	Commercial Waste Campaign - Broadcast an education campaign geared toward residents, businesses, and institutions to inform how to reduce environmental impacts generated by consumer choices. Include infographics to depict the waste stream cycle, sources, and quantities.
	Task Force for Institutional Waste - Create a task force to work with institutions to remove single-use plastics and minimize other large waste streams.
	Commercial Recycling- Mandate an equitable multi-family and commercial recycling program for new and existing properties with equivalent levels of service as trash collection at no additional cost to renters.
	Certification - Encourage businesses to enter corporate partnerships through established zero waste programs and reward businesses earning zero waste certification. Incentivize waste reduction through education regarding cost savings and marketing opportunities through green business challenges.
Objective 3: Reduce residential waste.	Residential Reuse - Inventory and promote access to informal tools/services for residential materials reuse such as Freecycle, NextDoor and others.
	Composting Measures - Establish an equitable citywide food waste diversion and reduction program that makes composting accessible to all by including educational measures for onsite/backyard composting, operational measures for weekly curbside pickup, and convenient drop-off composting. Prioritize city housing projects whose residents experience the highest levels of urban heat.
	Pay-As-You-Throw - Create a "Save As You Save"/"Reduce Trash - Save Cash" program that encourages reductions in the amount of trash going to the landfill by lowering monthly solid waste bills based on trash volume or weight.
	Packaging Waste - Promote and incentivize programs that encourage households to reduce the consumption of excess packaging by improving access to the local economy (e.g., farmers markets, local makers markets).

	Residential Waste Campaign - Create an accessible, large-scale education campaign for all residents about the incentives and benefits of reducing waste and the consequences of not reducing waste. Include infographics depicting the waste stream cycle, sources, and quantities, as well as environmental justice and health impacts related to landfills.
	Illegal Dumping- Develop protocols and cost considerations for responsible recycling and disposal of solar panels, batteries, and other byproducts of renewable energy and weatherization upgrades to ensure no burdens are placed on impacted communities.
	Recycling Streams - Prioritize and incentivize high-quality recycling systems/streams in all areas with a focus on historically underserved neighborhoods.
	Expanded Services - Upgrade municipal recycling services to the same pickup schedule, frequency, service territory, and equal or greater container size as the municipal solid waste program. Incorporate brush/bulk pickup services for extreme weather-related debris management
Objective 4: Reduce industrial waste.	Carbon Offsets - Establish partnerships that utilize landfill gas capture to offset carbon emissions.
	Materials Exchange - Promote materials exchanges for reuse of excess materials and waste stream diversion.
	Waste to Energy- Explore economic development incentives to attract companies with technologies to convert local waste into biofuels.
	Organic Waste - Align incentives to reduce organic materials including food waste from the industrial waste stream.
	Industrial Waste Campaign - Promote existing actions that reduce waste from industrial processes, prioritize required infrastructure improvements, and make measures transparent to the public.
	Community Advocacy - Advocate for state and regional policies aimed at reducing industrial waste, particularly from facilities located in or adjacent to frontline communities and/or in floodplains and flood-prone areas.
	Site Plan Review - As part of site plan review, implement measures to identify the potential impacts of new industrial facilities on neighboring communities, identify potential risks of locating hazardous materials in flood-prone areas, and incentivize waste reduction programs and manufacturing processes that minimize greenhouse gas emissions and other environmental impacts.
	Tracking - Incentivize industrial facilities to conduct annual waste audits and publish findings to identify potential impacts on the surrounding community.
	Certification - Promote and reward those companies earning zero waste certification through established programs and methods (e.g. USGBC's TRUE, SCS Global Services, etc).

Appendix K
Implementation Guide

Appendix K: Strategy Implementation Guide

Successful implementation of the strategies in this plan will require a continued equity-centered collaboration process by well-rounded Implementation Teams. A great deal of background information was gathered, extensive exploratory discussions were conducted during working group meetings, and research relating to each strategy was collected along the way. It is important that these findings and suggestions are considered and incorporated into the implementation project plans when applicable. To assist the transfer of information to each Implementation Team, a workbook (toolbox) containing 8 tabs (tools) was created for this purpose and will be shared with the City Steward responsible for each strategy. This toolbox will assist the Implementation Teams with project development and will also ensure consistent tracking, reporting and accountability to the overall long-term goals of the plan.

1- Implementation Instructions

1 **Introduction:** Schedule Meeting between City Steward and OOS Champion to review Implementation Tool, strategy details, guidance documents, additional resources, and clarify project and reporting expectations

2 **Approvals:** City Steward to discuss project with respective supervisor to identify potential project alignment, priority directives, staffing assignments, potential funding requests, project timeline, and other guidance as needed

3 **Team-Building:** Create Implementation Team (use suggestions as guidance) and schedule kick-off meeting

4 **Kickoff Meeting:**

a. Invite the OOS Champion to give a brief presentation of the RVAgreen Climate Equity Action Plan 2030 to the Implementation Team at the Kickoff Meeting

b. Review the 'Shared Accountability Framework' with the team (Tab 1)

c. Discussion: Group Expectations & Ground Rules (Tab 2)

d. Review components of the RVAgreen 2050 Implementation Toolkit (Tabs 3-8)

e. Complete 'Project Planning Worksheet' with the Team (Tab 4)

i. Clarify roles

ii. Delegate work assignments

iii. Identify funding requests

iv. Identify procurement needs

v. Clarify project timeline

f. Establish reporting requirements (Tab 8)

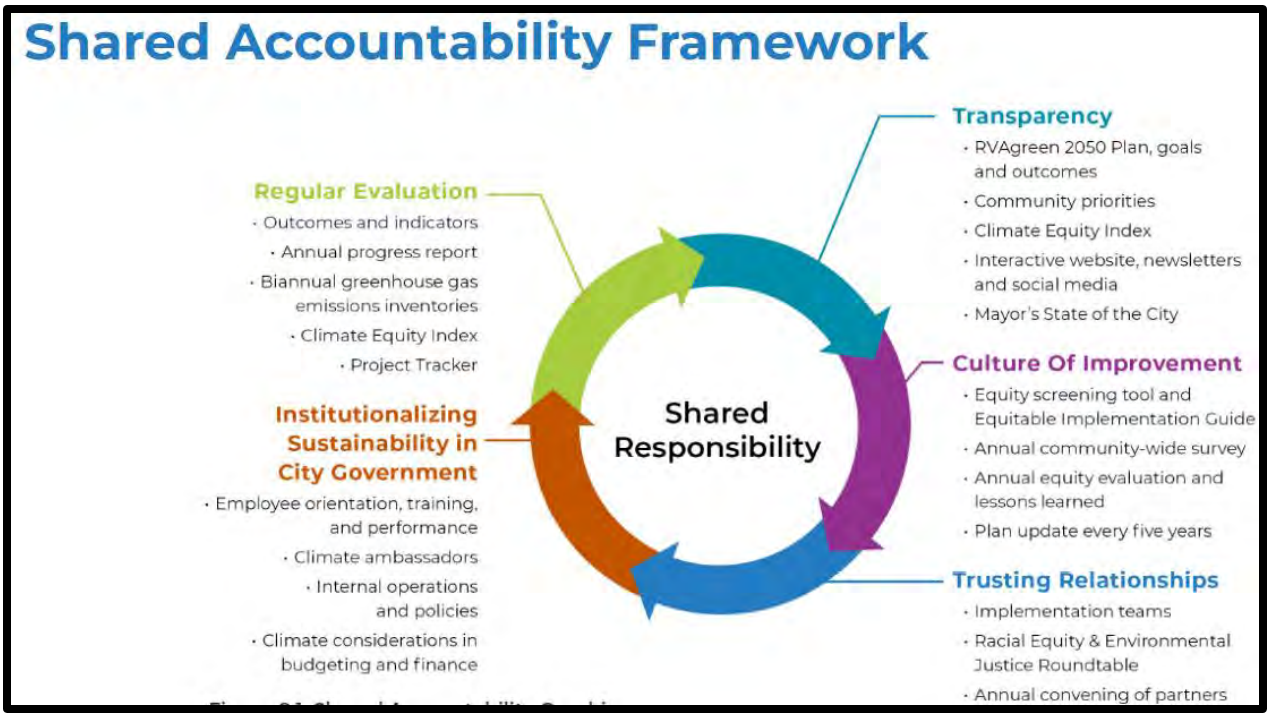
g. Schedule regular project meetings as necessary

h. Fill in "Implementation Action Plan" and update regularly (Tab 5)

5 **Reporting:**

a. Discuss content of reporting requirements with OOS

b. Agree on reporting expectations and timeline



2- Group Expectations

Technical working groups established their own group expectations in the fall of 2020 to assist with ground rules for effective collaboration. At the last meeting in June of 2022, working group members were asked to share advice with the Implementation Teams. The following table summarizes their recommendations:

#	RVAgreen 2050 Working Group Expectations & Lessons Learned
1	Aim for 100% collaboration and collaborative problem solving
2	DON'T BE INFLEXIBLE!
3	Work collaboratively with the community
4	COMMUNITY STAKEHOLDERS NEED TO BE INVOLVED FROM THE BEGINNING!!
5	Gather input from different people with different perspectives
6	Speak for yourself and avoid "WE ALL..." language
7	Open-ended questions are important and not having the answer off the bat is ok
8	"Step Up and Step Back"
9	Be prepared to be told that you're wrong
10	Don't get too committed to your ideas too early
11	Don't be afraid to be creative - "there are no dumb questions/ideas"
12	Get clear direction, buy-in, and empowerment from the top (i.e. department directors)
13	"Think FOR the community, think FROM the dais"

14	Shrink down big ideas to an elevator pitch, communicate the ROI, “sell” the great ideas
15	ELMO: "Enough Let's Move On"
16	7 Second Rule (after 7 seconds of silence move on)
17	When the big picture is intimidating, focus on the task at hand
18	Center discussions on practical solutions
19	Ask specific questions and make space for ideas (work methodically)
20	Check in and get input from all folks (specifically ask for ideas from people we haven’t heard from yet)

3- Strategy Background Details

During the plan development process background information for each strategy was collected from working group members, staff, stakeholders and through community engagement. All of the information is saved in a database and will be shared with the Implementation Teams. The following table summarizes the content areas of the collected information:

Project Overview				Timing					Team		
Strategy	Action	Summary Expectation	Reporting Expectation	Strategy Ranking	Action Ranking	Timeframe	Status	What obstacles esxist?	City Steward	Current Partners	Potential New Partners

Costs/Benefits					
Potential Costs	Estimated Benefits	Potential Funding Sources	Current Funding	Needed Funding	FY Budget Requests

Project Planning										
Current activities	What needs to happen to improve current activities?	What are some successful programs from other localities?	Equitable Next Steps	Staff Notes	Community Input	Internal Plan Alignment	External Plan Alignment	Resilience Impacts Addressed	Community Priorities Addressed	Relevant Legislation

Tracking					
Cumulative GHG Reductions Potentials (metric tonnes)	Suggested Metric for Tracking	Relevant Data Sources	Climate Equity Index Layers	Related Strategies	OoS Staff Planning Needs

4- Project Planning Worksheet

The following worksheet can serve as a guide for effective project development and consistent expectations across all strategy implementation activities. The information gathered on these pages during project initiation will also help to document the project expectations and equitable engagement requirements.

OFFICE OF
SUSTAINABILITY

2030 Climate Equity Action Planning Worksheet

PROJECT OVERVIEW	Strategy:				
	OoS Champion:				
	Action:				
	Project Expectation				
	Reporting Expectation				
IMPLEMENTATION TEAM	COR Steward:	*Name*	*Dept*	*Email*	*Title*
	Implementation Team:	*Name*	*Agency/Dept*	*Email*	*Role*

City of Richmond RVAgreen

OFFICE OF SUSTAINABILITY

2030 Climate Equity Action Planning Worksheet

PROJECT PLANNING	**Kickoff Meeting:**	***Date***	***Time***	***Location***
	Project Management Plan Outline:			
	FY Budget Request Overview:			
EQUITY PLANNING	**How is the Equity Screening Tool being used?:**			
	How is Climate Equity Index being used?			
	When relevant what is the plan for engagement of the frontline communities?			
NEXT STEPS	**Planned Activities:**			
	Planned Deliverables			
	Next Meeting Date			

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5- Implementation Action Plan

This portion of the workbook sets a timeline for the equitable next steps, plan deliverables, and reporting requirements spanning multiple fiscal years to serve as a long-term planning and budgeting guideline.

6- Equity Screening Tool

The Equity Screening Tool was developed by the Racial Equity & Environmental Justice to be used during each stage of the planning process. Working Groups used the tool during strategy development. Implementation Teams are expected to use the tool to further develop equitable next steps.

7- Climate Equity Index

The Climate Equity Index is an interactive tool created by the City of Richmond Office of Sustainability and can be used to explore factors that could make a community more susceptible to harm due to climate change. These factors can also be explored within the historical and current context of institutional racism that has created many inequities and caused Black or African American and Hispanic and Latino communities to be more susceptible to harm. A short tutorial on the Climate Equity Index can be seen here: https://www.youtube.com/watch?v=iNWkmZxY0Sk

The Climate Equity Index tool can be found at www.rvagreen2050.com in the bottom right of the homepage or:
https://cor.maps.arcgis.com/apps/webappviewer/index.html?id=e4d732f225fe457d83df11fe9bf71daf

8- Outcomes & Indicators

In order to be able to track progress toward the plan's long-term goals, 24 indicators will be measured by the OOS on a regular basis. Monitoring and reporting of the annual trend line of the indicators will help to ensure overall plan accountability. Ultimately, the indicators will inform as to whether or not Richmond is realizing the outcomes that the community wants to see as a result of successful implementation of the strategies. Each Implementation Team will review the indicators together and discuss project plans that will contribute to positive outcomes as measured by the applicable indicators.

#	Outcome	Indicator	Desired Trend	Reporting Frequency	Data Source & Notes
1	**Advanced green economy**	# and % of green jobs	Increase	Annual	To be determined. In 2013 the U.S. Bureau of Labor Statistics eliminated its Green Goods and Services Occupations data and publications program. Alternative methodology to be identified using best practices and peer city
		Number of residents completing training, education, and apprenticeship programs related to climate action and resilience by race and ethnicity	increase	Annual	City departmnents, higher education institutions, and partner organizations
2	**Cleaner and more efficient buildings**	Total building energy use (Btu)	decrease	Annual	Dominion Energy, City of Richmond
		Percent of households with high energy burden by race and ethnicity	decrease	Every other year	U.S. Census*
3	**Cleaner and more efficient transportation**	Percent of travel (mode share) **not** with single-occupancy internal combustion engine vehicles	increase	Every other year	U.S. Census*
		Percent of population within a 10 minute walk of a fixed-route transit stop with amenities by race and ethnicity	increase	Every other year	U.S. Census* + Greater Richmond Transit Company (GRTC)
4	**Climate-ready community**	Number of residents receiving information on climate change impacts and residents through website, social media, events, trainings, and other communications channels (to be defined)	increase	Annual	To be determined, methodology to be developed using Office of Sustainability communications platforms and tracking information.
		Percent of population facing "high vulnerability" to climate change per the Climate Equity Index by race and ethnicity	decrease	Every other year	RVAgreen 2050 Climate Equity Index
5	**Engaged and involved community**	Number of respondents to annual sustainability survey (online, paper, phone, and in-person)	increase	Annual	Annual community survey
		Number of respondents to annual sustainability survey (online, paper, phone, and in-person) by race, ethnicity, and income - *compare to citywide demographics*	increase	Annual	Annual community survey
6	**Improved air quality**	Citywide average Air Quality Equity Score	Increase	Every other year	To be determined: methodology to be developed with community partners modeled after Tree Equity Score, data to be gathered when air quality monitoring network is established (est. 2023/24).
		Average Air quality Equity Score by race and ethnicity		Every other year	To be determined: methodology to be developed with community partners modeled after Tree Equity Score, data to be gathered when air quality monitoring network is established (est. 2023/24).
7	**Increased flood resilience**	Number of incidents standing water, flooding, and emergency service during heavy precipitation events (whatever we can get)	decrease	Annual	Assemble data from RVA311, emergency service providers, and other sources to be identified.
		Number of calls/311 requests for standing water, flooding, and emergency service during heavy precipitation events by census tract (and/or race and ethnicity if that's available)	decrease	Annual	Assemble data from RVA311, emergency service providers, and other sources to be identified.

#	Outcome	Indicator	Desired Trend	Reporting Frequency	Data Source & Notes
7	**Increased flood resilience**	Number of incidents standing water, flooding, and emergency service during heavy precipitation events (whatever we can get)	decrease	Annual	Assemble data from RVA311, emergency service providers, and other sources to be identified.
		Number of calls/311 requests for standing water, flooding, and emergency service during heavy precipitation events by census tract (and/or race and ethnicity if that's available)	decrease	Annual	Assemble data from RVA311, emergency service providers, and other sources to be identified.
8	**Increased heat resilience**	Temperature difference between hottest and coolest areas of the city	decrease	Every other year	urban heat island study and/or satellite data
		Percent of population facing "high heat vulnerability" to climate change per the Climate Equity Index by race and ethnicity-race and ethnicity don't predict vulnerability	decrease	Every other year	RVAgreen 2050 Climate Equity Index
9	**Increased support for climate action and resilience**	Percent of RVAgreen 2050 actions funded	increase	Annual	City budget
		Annual $ allocated directly from the city or facilitated through a partnership with the city to community organizations for neighborhood-based climate action and resilience projects	increase	Annual	City budget
10	**Less landfill waste**	Total waste going to landfill (tons)	decrease	Annual	Transfer station operator and private
		Percent of households that have access to curbside/on-site recycling services by census tract	increase	Annual	U.S. Census*
11	**Lower greenhouse gas emissions**	Total community GHG emissions (MTCO2e)	decrease	Every other year	Office of Sustainability greenhouse gas emissions inventory
		Per capita GHG emissions by census tract (MTCO2e)	decrease	Every other year	Office of Sustainability greenhouse gas emissions inventory - cakculation
12	**More green space and trees**	Citywide average Tree Equity Score	increase	Every other year	American Forests Tree Equity Score Tool
		Percent of population within a 10 minute walk of a public park with green space by race and ethnicity	increase	Every other year	U.S. Census* + Department of Parks and Recreation data

City of Richmond
RVAgreen 2050

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